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PROTECTING AUTOMATED GUIDEWAY TRANSIT SYSTEM STATION SECURITY REQUIREMENTS

MARCH 1980

AUTOMATED GUIDEWAY TRANSIT TECHNOLOGY PROGRAM

U.S. DEPARTMENT OF TRANSPORTATION
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16. Abstract

This study addresses the issues of personal security on Automated Guideway Transit Systems (AGT), as they might be deployed in typical urban residential and nonresidential settings. Based upon a literature review, it outlines basic characteristics of existing transit crime, compares station design concepts for AGT and conventional rail transit, reviews the key environmental characteristics of AGT stations which may influence crime potential, inventories both existing and proposed countermeasures for transit crime reduction, identifies additional neighborhood resources which might be mobilized as countermeasures, reviews available techniques for predicting transit crime, and reviews available techniques for assessing countermeasures.

The report recommends a general approach for AGT station security requirements analysis which can be used by localities in site-specific AGT planning and engineering studies.

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PREFACE

The U.S. Department of Transportation's Urban Mass Transportation Administration (UMTA), in order to examine specific Automated Guideway Transit (AGT) developments and concepts, has undertaken a new program of studies and technology investigations called the Automated Guideway Transit Technology (AGTT) program.

The objective of one segment of the AGTT program, Predicting AGT System Station Security Requirements, is the development of guidelines for the assurance of actual and perceived passenger safety and security in AGT systems. This work was contracted, through the Transportation Systems Center (TSC), to a team composed of Dunlap and Associates, Inc., the University of Virginia, and the Vought Corporation.

The Systems Safety and Passenger Security (SS&PS) study has involved six related but separate tasks. Three were concerned with the development of guidebooks dealing with: 1) passenger security, 2) evacuation and rescue, and 3) passenger safety and convenience services. A fourth task required the development of a passenger value structure model; a fifth involved research on the retention of seated passengers during emergency stops; and a sixth involved the conduct of a joint Government and industry workshop to review and revise the three guidebooks.

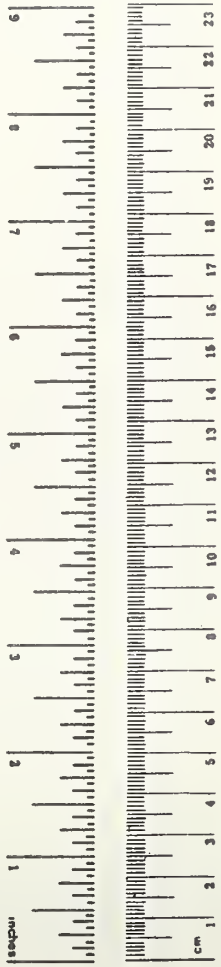
The authors wish to thank Dr. Donald Sussman, Dr. Arthur Priver, and Dr. Janis Stoklosa, all of the Transportation Systems Center; Mr. Robert Hoyler of the Urban Mass Transportation Administration; and Dr. Walter Hawkins, formerly of the Transportation Systems Center, for their support, guidance, and comments in performing this study.

It should be noted that much of the material and data reported in this final report was obtained from the University of Virginia, Charlottesville, VA as part of an allied contract DOT-TSC-1314. This material is provided in detail in report No. UMTA-MA-06-0048-79-7 prepared by the University of Virginia under subcontract to Dunlap and Associates, Inc.

METRIC CONVERSION FACTORS

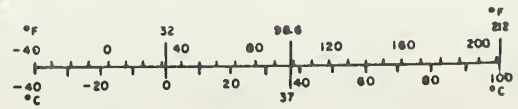
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inchss	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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OVERVIEW

The issues of safety and security are critical in determining the extent to which automated guideway transit (AGT) systems will be implemented. Concern with these issues stems primarily from the fact that the automated characteristics of these systems require few attendant employees. While this attribute is considered to be an economic advantage because of reduced labor costs, it is frequently viewed as a liability in terms of safety and security impacts. Regarding safety, there is the fear that absence of operators removes the availability of expert human intervention to correct mechanical failures. Given the extensive automation involved, there is the possibility of complete network or system breakdown if such failures are not automatically corrected and there are no operators to provide a final fail-safe mechanism.

Although operators traditionally occupy a precarious position relative to security and are generally ineffective to dealing with criminal incidents, their physical presence is of symbolic value. Many people, including a significant number of patrons, believe that operators *do* serve as a deterrent. A sense of confidence seems to result from a perception of operators as referees or de facto police. When they are absent, as in AGT systems, especially in smaller vehicles such as those envisioned for PRT, there is a potential danger for riders to feel that their territoriality is threatened by strangers occupying the unit. The lack of transit personnel and the inability of passengers to select their companion riders creates problems with respect to both surveillance and access control deficiencies.

Purpose

This study addresses only the issue of security on potential AGT systems, as they might be deployed in typical urban residential and nonresidential settings. Based upon a literature review, the project is intended to:

1. Outline basic characteristics of existing transit crime, with implications for AGT systems.

2. Compare design concepts for both AGT and conventional rail rapid transit stations with implications for AGT transit crime potential.

3. Review the key environmental characteristics of AGT stations which may influence crime potential, including both internal (station functions) and external (surrounding neighborhood) environmental settings.

4. Inventory both existing and proposed countermeasures for transit crime reduction, as related to existing conventional transit systems.

5. Identify additional neighborhood resources which might be mobilized as supplementary countermeasures, in terms of neighborhood response to crime in general.

6. Review available techniques for predicting transit crime, as a first step in developing a capability for assessing crime reducing countermeasures.

7. Review available techniques for specifically assessing countermeasures to reduce transit crime that are generally applicable in association with designing and evaluating any new transit system, but with particular reference to AGT.

8. Identify a recommended set of techniques for assessing those countermeasures that might be associated with AGT stations.

9. Recommend a general approach and methodology for AGT station security requirements analysis which can be used by localities in site-specific AGT planning and engineering studies.

Scope of the Study

Perceived Versus Empirical Security

The differences between *perceived* security and *empirical* security (as measured by transit crime statistics) are a major theme in the study, and present a major obstacle to precise analysis. The *perceived* threat of crime may, for example, be sufficient to reduce AGT ridership potentials significantly. But, as one researcher has observed (75),

> "The extent to which crime affects ridership is still something of a mystery. Several surveys have tried to get at it but the relationship remains elusive."

The relationship is particularly elusive for AGT systems, since empirical data are not available on either demand levels or crime impacts, except in special environments. Effects on AGT ridership are expected to be as much the result of people's perceptions of safety and security impacts as of their actual incidence. A significant part of the problem with respect to analysis is the basis of such perceptions and ways in which the transmission of information might be modified.

Consequently, any attempt to predict AGT system station security requirements is faced with difficulties. Not the least of these is the absence of operating AGT systems in any conventional urban setting.* Thus, directly applicable field studies or even the analysis of AGT crime data are not possible. As a result, it has been necessary to rely on studies of conventional transit modes, as they relate to crime and crime countermeasures and ways of predicting the incidence of crime and the effectiveness of countermeasures.

Transit Versus Neighborhood Crime

Paralleling this emphasis is the study's concern with neighborhood crime and countermeasures and their applicability to the AGT transit environment. The relationship between transit and neighborhood crime is a second key theme for this project. In addition to the empirical documentation for this relationship (10), (11), there is a logical basis for examining it.

Since the largest proportion of patrons using a neighborhood transit station live in the area and a significant percentage of those using a downtown station work or shop in the area, it is reasonable to expect that there is a potential for transferring effective countermeasures from an area's non-transit environment to its transit environment. The transit system does not exist in isolation, although it is often treated in studies as if it does. If crime countermeasures are not effective or cause resentment in an area, it is also worthwhile to pause before implementing them in that area's transit station.

Data Limitations

Data limitations are a third major theme in the report. The literature on transit crime countermeasures generally says little about predicting how well such measures might be expected to work in conventional transit settings, let alone in AGT settings. Actual data on observed countermeasure effectiveness is also quite limited and fragmentary.

Since data on the effectiveness of transit crime countermeasures are limited, it follows that data comparing countermeasure effectiveness across transit modes are notable by their absence. Almost without exception, studies of transit crime examine mass transit systems on a city-by-city basis, without any cross-city comparison of transit modes. This lack of cross-city or even inter-modal comparison, and the related lack of microlevel analysis of the relationship of system characteristics to countermeasure effectiveness, greatly limits the utility of conventional transit study findings in identifying security implications for AGT systems.

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* The only operating AGT systems are in special environments such as airports (Dallas-Ft. Worth), universities (University of West Virginia), and amusement parks (Disney World).

Very little presently exists in the literature which relates known social science prediction/evaluation techniques to the specific topic of transit crime (not to mention transit *station* crime or *AGT* transit station crime). Consequently, liberal use of professional judgment is made at several points in the report, particularly in the final chapter which recommends an integrated methodological approach.

Countermeasures Versus Prediction Techniques

A final major theme of the work is the need to keep the distinction between *countermeasures* and *prediction techniques* clearly in mind. This report does *not* evaluate or recommend transit crime reduction countermeasures themselves. In fact, this is the subject of a parallel TSC research effort (30). Instead, the major substance of the report is limited to *techniques for evaluating* countermeasures, their possible effectiveness, and their relative need, *prior* to actual implementation. This need to *predict* security requirements (or expected countermeasure effectiveness) is particularly crucial for yet-to-be implemented urban AGT systems.

The report is organized in three major parts. In Part I, current transit crime patterns are reviewed and related to AGT station design and station environment characteristics. Part II provides a brief inventory of both ''conventional'' countermeasures for transit crime reduction, as well as neighborhood resources which might be applied for the same purpose. Part III reviews techniques available for both predicting transit crime and assessing countermeasure effectiveness, and offers recommendations for analysis strategies to be employed in local AGT studies. Traditional as well as innovative analysis techniques are covered.

Methodology

This report is based entirely on a review of the literature on transit crime and security. Searches were made at the Transportation Center Library, Northwestern University; the National Technical Information Service (NTIS); and the consultants' libraries for recent (post-1969) references on transit safety. From these initial searches, a basic list of references was compiled. This list was later supplemented with references identified through a computerized search by the National Criminal Justice Reference Service (NCJRS). The list was also expanded on a continuing basis, and references cited in the initial documents were reviewed. As a result, a total of over 200 references on transit crime and security has been identified. A representative list of these references is appended.

Documents which seemed especially pertinent to project objectives were selected for review. Emphasis was placed on those which contained (1) empirical findings; (2) substantive presentations of techniques or methodologies for data collection, analysis, or evaluation; or (3) consideration of crime and crime-reducing countermeasures specifically related to AGT systems. Thirty-four such documents were selected and reviewed. Reviewers recorded highlights of the documents and summarized and critiqued them on abstracting forms developed for this purpose.

It soon became apparent that a few reports were cited frequently in other documents and encompassed much of what is known about transit crime and security. Some of these key documents were reviewed by more than one reader, due to their importance and the quantity of findings contained in some of them. Since they form the basis of much of this literature review, it is worthwhile to list them at this point:

-- Carnegie-Mellon University, *Security of Patrons on Urban Public Transportation Systems* (1975).

-- Chaiken, Jan M., et al., *The Impact of Police Activity on Crime: Robberies on the New York Subway* (1974).

-- Schnell, John B., et al., *Vandalism and Passenger Security* (1973).

-- Shellow, Robert, et al., *Improvement of Mass Transit Security in Chicago* (1973).

-- Sidley, Norman A. and Shellow, Robert, *Automated Small Vehicle Fixed Guideway Systems Study—Interim Report: Patron Security* (1974).

-- Siegel, L., et al., *An Assessment of Crime and Policing Responses in Urban Mass Transit Systems* (1977).

-- Stanford Research Institute, et al., *Reduction of Robberies and Assaults of Bus Drivers* (1970).

An annotated bibliography of these key references and other reports is appended.

The key documents provide findings from a range of studies conducted in cities throughout the United States and Canada. They employed varying methodologies, ranging from the use of crime data recorded by the police, through victimization and attitude surveys, to speculative analysis of crime countermeasure requirements for AGT systems. Thus, comparability of the findings is difficult. Given the objectives of this project, rather than evaluating the methodologies of previous studies in depth, it seems more important to present an inventory and review of basic techniques and then to move to a consideration of the implications of these analytic and/or predictive techniques for AGT system station security requirements.

Part I
AGT AND TRANSIT CRIME

Chapter 1
CHARACTERISTICS OF TRANSIT CRIME

Crime and fear of crime on the nations's mass transit systems have been growing concerns in recent years. Everyday observation and the findings of various surveys indicate the importance of security as an issue for transit patrons. Mass transit is marketed as a socially desirable form of behavior due to its low cost, energy savings, and environmental advantages. Yet, there is reason to suspect that it will be difficult to lure people away from the safety and convenience of the private automobile despite its social disadvantages unless the transit alternative is quite attractive.

Automated guideway transit (AGT) systems have been proposed as an alternative which can compete with the private automobile. Part of their attractiveness lies in the high degree of demand responsiveness possible in some AGT modes. This capability is possible in large part due to the automated nature of AGT modes. Such automation means an absence of human operators. This raises concerns about the security of patrons. Thus, the system may be unattractive in one important dimension—security—because of the source of its strength in another dimension—convenience.

The need, then, is to determine how such AGT systems can maintain their cost and convenience advantages and yet appear to be secure as well as actually being secure. As background, this chapter examines some findings regarding crime on conventional transit and relates them to implications for AGT systems and their security requirements.

Common Crime Problems on Transit

Findings from several of the most important recent studies of transit crime have been summarized by Siegel et al. (78), as shown in Table 1. Of note is the consensus regarding the prevalence of transit crime in the *station* rather than on the vehicles. This finding provides a rationale for the focus of this project on AGT system *station* security requirements.

Table 1
TRANSIT CRIME PROFILE--ENVIRONMENTAL CHARACTERISTICS

ENVIRONMENTAL CHARACTERISTICS		CARNEGIE-MELLON UNIVERSITY "SECURITY OF PATRONS"		RONALD JOHNSON, "MASS TRANSIT IN CHICAGO,"	PAUL GRAY, "ROBBERY AND ASSAULT OF BUS DRIVERS,"	SRI AND UNIVERSITY OF CALIFORNIA, "PREVENTION OF ROBBERIES AND ASSAULTS OF BUS DRIVERS," V.I.
SETTING	PLATFORMS	VARIANCE OF 40 AMONG STATION CRIME RATES. (p.12) "HIGHEST CRIME STATIONS ARE...IN THE AREAS HAVING THE HIGHEST NON TRANSIT CRIME RATE" (p.12) (ALSO TRUE FOR NYC--p.35)	"MOST ROBBERIES [IN CHICAGO] OCCURRED ON STATION PLATFORMS." (p.34) OR IN LOBBIES AGAINST STATION AGENTS (p.34) 30% ON TRAIN 70% IN STATION (p.35)	478 (61.2%) OF 782 (p.231) PLATFORMS 304 (38.8%) OF 782 OTHER (CARS) = 304 OF 1066 TOTAL (p.231)	70% ROBBERIES NOT ON BUS (p.262)	70% ROBBERS NOT ON BUS (p.11)
	LOBBIES					
	SUBWAY CARS/BUSES					
	HIGH CRIME NEIGHBORHOODS					
	UNKNOWN					
MONTH (BY QUARTER)	JANUARY-MARCH					
	APRIL-JUNE					
	JULY-SEPTEMBER					
	OCTOBER-DECEMBER					
	UNKNOWN					
DAY OF WEEK	MONDAY	"HEAVIEST ROBBERY PERIODS OCCURRED ON FRIDAY AND SATURDAY NIGHTS." (p.33)		"50% OF ALL ROBBERIES OCCURRED ON THE WEEK-ENDS [FRIDAY-SUNDAY] (p.229)		
	TUESDAY					
	WEDNESDAY					
	THURSDAY					
	FRIDAY					
	SATURDAY					
	SUNDAY					
TIME OF DAY	MIDNITE-4 A.M.	"MORE TRANSIT ROBBERIES...DURING NIGHTTIME...THAN... DAYTIME" (p.12) (CHICAGO) "MAJORITY ...OCCURRED...BETWEEN 6 P.M. TO [SIC] MIDNIGHT" (p.33)			(OAKLAND) n = 116 (1967) 78% ROBBERIES OCCURRED BETWEEN 6 P.M. AND 6 A.M. (p.262)	"GREAT MAJORITY OF CRIMES OCCURRED BETWEEN 6 P.M. AND 6 A.M." (p.11)
	4 A.M.-8 A.M.					
	8 A.M.-NOON					
	NOON-4 P.M.					
	4 P.M.-8 P.M.					
	8 P.M.-MIDNITE					
	UNKNOWN					
TYPE OF WEAPON	GUN	GUNS "RARELY USED... AGAINST PASSENGERS" (p.12) [CHICAGO] EVEN DIVISION "BETWEEN ARMED AND STRONG-ARMED OFFENSES" (p.33)				60% CASES GUN WAS USED. (n = 707) (p.11)
	KNIFE					
	BODILY					
	OTHER					
	UNKNOWN					
RELATION OF VICTIM TO OFFENDER	STRANGER					
	ACQUAINTANCE					
	RELATIVE					
	UNKNOWN					
MODUS OPERANDI	APPROACH					
	CONDUCT					"TYPICAL...TIMES ARE LESS THAN THREE MINUTES" (p.11)
	ESCAPE	"AS RAPIDLY AS POSSIBLE" (p. 12, 33)			"GREAT MAJORITY" ON FOOT (p.262)	97.5% ROBBERS ESCAPED USUALLY ON FOOT (p.11) n = 707
CRIME CONSEQUENCES	INJURY	"MORE CAUCASIAN THAN BLACK VICTIMS RECEIVED INJURIES." (p.34) PASSENGER LOSS AVERAGED <$20 STATION AGENT >$100			20% ROBBERIES LED TO INJURIES (p.262)	65% DRIVERS WERE NOT INJURED (p.11)
	DEATH					
	LOSS				AVERAGE LOSS = $117 (p.262)	AVERAGE TAKE = $101 (p.11)

Table 1
TRANSIT CRIME PROFILE--ENVIRONMENTAL CHARACTERISTICS (cont'd)

ENVIRONMENTAL CHARACTERISTICS		CARNEGIE-MELLON UNIVERSITY "IMPROVEMENT OF MASS TRANSIT SECURITY IN CHICAGO."		J. CHAIKEN, ET AL., "THE IMPACT OF POLICE ACTIVITY ON CRIME."		
SETTING	PLATFORMS LOBBIES SUBWAY CARS/BUSES HIGH CRIME NEIGHBORHOODS UNKNOWN	HIGH CRIME AREAS COINCIDE WITH HIGH UNEMPLOYMENT AREAS (p.74)	BUS CRIME DOES NOT SEEM TO CORRELATE TO CRIME LEVELS IN SURROUNDING NEIGHBORHOODS (p 83) ROBBERIES OCCURRED ON BUSES (p.93)	ROBBERS "CONCENTRATE ON A SMALL NUMBER OF STATIONS AND PORTIONS OF TRAIN ROUTES" (p.vii) 1970 = 50%/50% 1971 = 69%/31% STATIONS/TRAINS (p.33)	# ROB. # STA. % 0 149 30.8 1 105 21.7 2-5 159 32.8 6-10 53 11.0 10+ 18 3.7 T 484 100 (p.40)	"SUBWAY ROBBERY TENDS TO BE HIGHEST IN AREAS HAVING A HIGH SURFACE CRIME RATE" (p.44)
MONTH (BY QUARTER)	JANUARY-MARCH APRIL-JUNE JULY-SEPTEMBER OCTOBER-DECEMBER UNKNOWN	APRIL AND AUGUST ARE "LOW DANGER," SEPTEMBER AND DECEMBER ARE "HIGH DANGER" (p.65)			(JANUARY-APRIL, 1970-1971)	
DAY OF WEEK	MONDAY TUESDAY WEDNESDAY THURSDAY FRIDAY SATURDAY SUNDAY	50% ROBBERIES ON WEEKENDS (p.59)	TOKEN BOOTH ROBBERY IS UNIFORM (p.36-37) PASSENGER PEAKS ON SUNDAY			
TIME OF DAY	MIDNITE-4 A.M. 4 A.M.-8 A.M. 8 A.M.-NOON NOON-4 P.M. 4 P.M.-8 P.M. 8 P.M.-MIDNITE UNKNOWN	67% ROBBERIES OCCUR 6 P.M.-MIDNITE (p.62) (BATTERIES OCCUR ABOUT 2-HOUR EARLIER RANGE)	BUS ROBBERY PEAKED 2-3 P.M. (10%) AND 9 P.M.-MIDNITE (25%) 2 P.M.-MIDNITE (75%) (p.88)	PRE-PATROL: 10 P.M.-6 A.M. 2-4 P.M. POST-PATROL: 2-4 P.M. SOME SHIFT TO PRE 8 P.M. AND POST 4 A.M. (p.36)		
TYPE OF WEAPON	GUN KNIFE BODILY OTHER UNKNOWN	33% ROBBERIES/GUNS 20% ROBBERIES/KNIVES 14% ROBBERIES/FISTS, ETC. 33% ROBBERIES/UNARMED (p.77)		GUN USED ONLY 8% OF PASSENGER ROBBERIES, 3/4 NO WEAPON - TOKEN BOOTH ROBBERIES HAD GUNS OR SIMULATED GUNS IN ALL BUT 7% (p.49)		
RELATION OF VICTIM TO OFFENDER	STRANGER ACQUAINTANCE RELATIVE UNKNOWN					
MODUS OPERANDI	APPROACH CONDUCT ESCAPE	SINGLE OFFENDER = FRONTAL APPROACH 2 OFFENDERS = REAR OR FRONTAL OR 2-SIDED APPROACH 3+ OFFENDERS = SEVERAL DIRECTIONS (p.76) QUICKLY ONTO STREET = 75% (p.78)		ONTO STREET, IN "KNOWN" NEIGHBORHOODS (p.vii)		
CRIME CONSEQUENCE	INJURY DEATH LOSS	33% ROBBERY VICTIMS HURT (p.77) MONEY, CREDIT CARDS JEWELRY RANGE = $20-$100+ (p.77)		SOME INJURY TO PASSENGER IN ROBBERY (p.49) "TAKE" = $50 PASSENGER ROBBERY $150 TOKEN BOOTH (p.vi)	PASSENGER TAKE RANGE = $41 (1970) $82 (1972) BOOTH = $250 (1970) $127 (1971) (p.50)	

Source: Reference 78, pp. B-2, B-3

On the other hand, whether the same distribution of crime will also be true of AGT systems remains to be seen. Two characteristics of AGT systems suggest that the proportion of station crime to vehicle crime will be smaller than on conventional transit. First, the aforementioned lack of operators on the vehicles may lead to more crime in that setting. Second, shorter headways will reduce exposure time and, presumably, incidence of crime in the stations. Demand-responsive modes should increase such reductions in headway and exposure time.

The studies also agree on the prevalence of robbery on weekends and of robbery and other crimes at night. Since robbery is a particularly fear-provoking offense (a third of the robbery victims in the Chicago study were injured), if these findings can be generalized to AGT, they have implications for the temporal targeting of countermeasures, assuming that displacement effects (increasing crime during another time period) would not reduce the impact of such an effort.

Findings that bus crime is markedly lower than rail rapid transit crime, and that bus crime does not correlate with neighborhood crime, should be interpreted with caution. Since bus stops generally are not enclosed and set apart from the rest of the area in the same way as other transit stations, it is easy for bus stop crimes to get ''lost'' in neighborhood crime statistics and not be reflected in transit crime statistics. The implication for AGT systems is that, to the extent that stations are less enclosed and encapsulated than conventional rapid rail transit stations, the threat to patron security in AGT stations will be less apparent. At the same time, however, potential patrons, who are, after all, more concerned with the safety of the entire transit experience from portal-to-portal rather than with the vagaries of crime statistics, may limit their ridership more than the understated station crime data would suggest.

Table 1 also provides a summary of other environmental characteristics of transit crime, for the six previous studies which were considered. In addition to station (platform or lobbies) vs vehicle settings (and/or high-crime neighborhood settings) for transit crime, as well as temporal settings (day of week and time of day), the table also covers seasonal variations (yearly quarter), types of weapons utilized, modus operandi of criminals, and consequences of crimes (injury, death, loss of property). Though not all of the studies reviewed analyzed these different environmental characteristics, the checklist is a useful one.

Transit Crime and Fear of Crime

Whether due to personal experience, observation, hearsay, or media accounts, people are afraid of crime on mass transit systems. This fear is no doubt intensified by the stories of terror in the subway or on the bus which perhaps promote a fear that is disproportionate to the actual threat. Yet other less dramatic, but still serious, incidents occur with greater frequency. Such crimes against persons as robbery, assault and battery, rape, and homicide are a source of fear whether they occur in a transit station, on the street, or in an apartment.

When we talk of transit crime, however, we include vandalism, fare evasion, petty theft, and other property crimes and lesser crimes against persons which are not intimidating in the same sense as the more feared crimes against persons. Yet, it is the less serious crimes which constitute the great bulk of the crime problem on transit. Also, it is the most serious (and less frequent) crimes, such as aggravated assault and battery, rape, and homicide, which may be among the most difficult to combat effectively through the use of countermeasures.

These crimes share with vandalism an expressive attribute. This is in contrast to the *instrumental* nature of crimes such as theft and robbery which serve pecuniary motives. Presumably it should be possible to reduce the amount of instrumental crime by reducing opportunities for illegally obtaining money, by instituting target hardening and other access control measures, and by making the probabilities of arrest greater through increased surveillance.

It is more difficult to imagine realistic countermeasures for expressive crimes, involving as they often do frustration, passion, or some other non-instrumental motivation. Vandalism, for example, has been described as an expression of revenge for a real or imagined hurt. An appropriate countermeasure then would be one preventing the feelings of hurt from developing. Perhaps by allowing for legitimate means of creative expression in stations, e.g., graffiti boards, or by making the transit system seem less alien, reductions in vandalism could be achieved. But it is not always apparent how countermeasures of this rather abstract type should be implemented. Rather than dealing with motivations or causes, it might be more effective in the case of vandalism to incorporate target-hardening countermeasures such as the use of vandal-resistant materials.

Such an approach might be effective in dealing with vandalism. However, vandalism does not seem to be the kind of crime which provokes fear and reduces ridership. Crimes which do, such as aggravated assault and battery, rape, and homicide, seem more intractable and less amendable to traditional countermeasures directed at either causes or consequences. Even so, if a frustration-aggression hypothesis is tenable, incidents of assault and battery might be reduced in AGT stations by reducing crowding through the use of short headways.

There is one type of crime which is instrumental in nature and probably ranks among the most feared. That is the crime of robbery. As an instrumental crime, it may be susceptible to countermeasures. As a feared crime, its reduction might be particularly important in increasing patron confidence in the system. It also is a frequently occurring category of transit crime. It seems then that a focus on reducing robbery might be a cost-effective emphasis.

AGT stations have a built-in advantage in countermeasures against robbery in that they are to include automated fare collection. This would eliminate robberies of ticket agents, a major type of robbery in conventional transit. However, again, that which is most tractable is not of the greatest concern to patrons. Countermeasures

must be sought and developed which protect patrons from robbery in stations and in vehicles.

Patron Participation: Offenders, Victims, and Witnesses

Much of what is known about the characteristics of the perpetrators, victims, and witnesses of transit crime is usefully summarized in Tables 2, 3, and 4 from Siegel et al. (78) and Sidley and Shellow (77). Table 2 presents nine variables on offenders from four major studies. Table 3 includes seven variables on victims derived from the findings of six major studies. Table 4 shows trichotomous confidence and relevance ratings of 37 conclusions based on studies on transit crime in Chicago and New York.

In Tables 2 and 3, the large number of empty cells graphically illustrates the gaps existing in our knowledge of transit crime. For those variables for which information is available, the findings from different studies are not always strictly comparable. This reinforces the observation by some researchers in the field that there is a need for uniform and comprehensive data collection procedures before comparisons among transit systems can be drawn with confidence.

The data from the studies, as presented in Tables 2 and 3, also seem to suffer from a lack of reference to base numbers for some of the variables. Information on the characteristics of transit crime offenders and victims is of incomplete value for drawing implications regarding potential countermeasure application, unless the same type of information is available on the characteristics of the general transit patron population. For example, a finding that 50 percent of victims are under 50 years of age has entirely different meanings when 50 percent of the general transit patron population is under 50 than 25 percent or 75 percent of patrons are in that age group.

Given these shortcomings, the major highlights of Tables 2, 3, and 4 are:

-- Ninety percent of offenders tended to be black males, more often than not operating in groups of two or more.

-- A majority of victims were white males, about one-third aged 21 to 30 and one-quarter aged 31 to 50.

-- Over 90 percent of passenger victims were alone, and 70 percent of bus drivers had zero to four passengers, when a transit crime occurred.

-- Nearly 20 percent of victims were transit employees.

Table 2
TRANSIT CRIME PROFILE--OFFENDER CHARACTERISTICS

MASS TRANSIT CRIME PROFILE - OFFENDER CHARACTERISTICS

OFFENDER CHARACTERISTICS		CARNEGIE-MELLON UNIVERSITY "SECURITY OF PATRONS..."	J. CHAIKEN, "THE IMPACT OF POLICE ACTIVITY ON CRIME..."	SRI AND UNIVERSITY OF CALIFORNIA, "REDUCTION OF ROBBERIES AND ASSAULTS OF BUS DRIVERS." V.I.	CARNEGIE-MELLON UNIVERSITY, "IMPROVEMENT OF MASS TRANSIT SECURITY IN CHICAGO," APPENDIX
CITY RESIDENT	YES				
	NO				
	UNKNOWN				
	IN OFFENDER'S CENSUS TRACT				
	OUTSIDE OFFENDER'S CENSUS TRACT				
	UNKNOWN				
SEX	MALE	"TEND TO BE...MALE" (p.12) (CF-RAND) (p.33)		"OVER 95 PERCENT" (p.12)	1112 (97.8%)
	FEMALE				11 (1.0%)
	UNKNOWN				11 (1.0%) n = 1134 (p.72)
RACE	BLACK	"TEND TO BE...BLACK" (p.12) (CF-RAND)	"GENERALLY" (p.vi) "OVER 90 PERCENT" (p.49) 85% ARRESTEES (p.49)	"90 PERCENT" (p.12)	1094 (96.6%)
	WHITE				18 (1.6%)
	CHICANO				8 (.7%)
	OTHER				13 (.9%)
	UNKNOWN				n = 1133 (p.73)
AGE	LESS THAN 18	"TEND TO BE EXTREMELY YOUNG" (p.12) (CF-RAND)	PASSENGER ROBBERS AVERAGE AGE WAS LESS THAN 17	"MOST...WERE BETWEEH 16 AND 20" (p.12)	<16/87 (8%)
	18-24		TOKEH BOOTH ROBBERS AVERAGE 22 (p.vi, p. 49)		16-20/495 (46%)
	25-50	"MOST WERE UNDER 30" (p.33) (CF-CHI., p. 49)			21-30/415 (38%)
	OVER 50				31-50/72 (6.6%)
	UNKNOWN				51-65/1 (.1%) 16 (1.5%) n = 1086 (p.73)
EDUCATIOH	LESS THAN 8TH				
	8TH-11TH				
	HIGH SCHOOL				
	MORE THAN HIGH SCHOOL				
	UNKNOWN				
EMPLOYMENT STATUS	EMPLOYED				
	UNEMPLOYED				
	UNKNOWN				
OFFENDER SITUATIONS	ALONE	"OFTEN BELONG TO GROUPS" (p.12)	"FREQUENTLY OPERATE IH GROUPS" (p.vi) "TOKEH BOOTH ROBBERS... OPERATE SINGLY OR IH PAIRS" (p.vi) 3/4 OF THESE WERE SINGLE (p.49)	43% (p.12) 33% (p.12)	432 (38%)
	2				313 (28%)
	3				247 (22%)
	4 OR MORE				137 (12%)
	UNKNOWN				n = 1129 (p.72)
CRIMINAL RECORD	ROBBERY	"SOME...CAREERS INCLUDE A LARGE NUMBER OF CRIMES" (p.12) (CF-RAND)	OF 79 ARRESTEES, MOST WERE ASSOCIATED WITH 3 OR FEWER HOLOUPS (p.51)		
	VIOLENCE				
	OTHER		IB ARRESTEES WERE RESPOHSIBLE FOR 34% OF 663 TOKEN BOOTH ROBBERIES (p. 55)		
	UNKNOWN		"MANY [TOKEH BOOTH ROBBERS] ARE HARCOTICS ADDICTS" (p.vi)		

Source: Reference 78, page B-11.

Table 3
TRANSIT CRIME PROFILE--VICTIM CHARACTERISTICS

MASS TRANSIT CRIME PROFILE - VICTIM CHARACTERISTICS

VICTIM CRIME PROFILE		CARNEGIE-MELLON UNIVERSITY "SECURITY OF PATRONS"	RONALD JOHNSON, "MASS TRANSIT IN CHICAGO."	PAUL GRAY, "ROBBERY AND ASSAULT OF BUS DRIVERS."	SRI AND UNIVERSITY OF CALIFORNIA, "REDUCTION OF ROBBERIES AND ASSAULTS OF BUS DRIVERS." V.I.	CARNEGIE-MELLON UNIVERSITY "IMPROVEMENT OF MASS TRANSIT SECURITY IN CHICAGO."	CARNEGIE-MELLON UNIVERSITY "IMPROVEMENT OF MASS TRANSIT SECURITY IN CHICAGO." APPENDIX
CITY RESIDENT	YES NO UNKNOWN						
LOCATION OF OFFENSE	IN VICTIM'S CENSUS TRACT OUTSIDE VICTIM'S CENSUS TRACT UNKNOWN						
SEX	MALE FEMALE UNKNOWN	MORE THAN 50% MALE (p.33)	"MAJORITY WHITE MALES" (p.230)				70.2% 28.6% 1.2% n = 1041 (p.65)
RACE	BLACK WHITE CHICANO OTHER UNKNOWN	"OVER 50%" (p.33)	"OF FEMALE VICTIMS, A SIZEABLE MAJORITY WERE BLACK (p.230)[38] "MAJORITY... WHITE MALES" (p.230)				40.6% 52.9% 4% 2% .6% n = 1039 (p.65)
AGE	LESS THAN 18 18-24 25-50 OVER 50 UNKNOWN	"MOST...UNDER 50" (p.33)					3.7% <16 16 <11.1% <20 21 <35.7% <30 31 <27.8% <50 51 <14.9% <65 65 <4.5% 2% n = 997 (p.64)
VICTIM SITUATION	ALONE 2 3 OR MORE	"TEND" TO BE ALONE (p.12) ALMOST ALWAYS ALONE (p.33)	"GENERALLY... ALONE" (p.230)	56% (ALONE BUS DRIVERS, NO PASSENGERS) (p.262)	40% OF 500 CASES, DRIVER WAS ALONE, 30% OF CASES, 1-4 PASSENGERS (NOT ROBBED) (p.11)	"OVER 90%" (p.68) "A FEW" (p.68) ALMOST NONE (p.68)	93.1% 5.1% 1.6% n = 1128 (p.64)
EMPLOYMENT	EMPLOYED UNEMPLOYED UNKNOWN	"C.T.A. EMPLOYEES...STUDENTS, AND SERVICE WORKERS WERE PREVALENT." (p.33)			BUS DRIVERS		CTA EMPLOYEES 18.4% SERVICE 16.7% STUDENTS 16.4% CLERICAL 13.4% OTHERS ----- n = 961 (p.68)

[38] TWO-THIRDS OF FEMALE VICTIMS OVER AGE 30 WERE WHITE (p.230).

Source: Reference 78, page B-14.

Table 4
CONFIDENCE AND RELEVANCE RATINGS--TRANSIT CRIME STUDY FINDINGS

	Conclusion	Confidence	Probable Relevance
1.	Majority of crimes occur in the evening	H	H
2.	Heaviest robbery period is Friday and Saturday night	H	M
3.	Robbery victims are lone individuals	H	H
4.	Transit employees were most frequent robbery victim group	M	M
5.	Robberies frequently are perpetrated by groups of two or three	H	M
6.	Offenders were most often young male Blacks	M-L	M-L
7.	Most victims are robbed on the station platform while they await the train	H	H
8.	When robbery occurs in the train it usually occurs while train is in motion between stations	H	H
9.	Very few witnesses report transit robberies	H	H
10.	Weapons (revolvers or knives) were used in a majority of cases	M	L
11.	Majority of robbery victims are not injured	H	M

Source: Reference 77, pages 13-16

Table 4
CONFIDENCE AND RELEVANCE RATINGS--TRANSIT CRIME STUDY FINDINGS (cont'd)

	Conclusion	Confidence	Probable Relevance
12.	Money, jewelry, credit cards were most often stolen	H	M
13.	Robbers tried to escape as quickly as possible	H	H
14.	When robbery occurred in station, robber fled to the street	H	H
15.	When robbery occurs in train robber flees at next stop	H	H
16.	Robbers rarely pull emergency stop	H	H
17.	Most robberies were self reported by the victims	H	H
18.	The shorter the delay between crime and arrival of police, the greater the apprehension rate	H	H
19.	Those stations where robbery is highest have high surface crime	H	H
20.	Most batteries occur during the evening rush hour	M	H
21.	Geographic distribution of battery is similar to robbery	L	H

Source: Reference 77, pages 13-16.

Table 4
CONFIDENCE AND RELEVANCE RATINGS--TRANSIT CRIME STUDY FINDINGS (cont'd)

Conclusion	Confidence	Probable Relevance
22. Most battery victims are lone individuals	M	M
23. Most batteries occur on station platforms	L	M
24. About half of the batteries are carried out by lone individuals	M	L
25. Half the batteries are carried out by gangs of four or more	M	L
26. Those who commit battery are young, male and Black	M	M-L
27. Most batteries involve no weapon	H	L
28. Most victims who were injured required hospital attention	L	M
29. Those commiting battery attempted to exit the system as fast as possible	M	H
30. Most victims of battery reported the crime themselves	H	H
31. Most crimes against people (CAP) occurred during morning rush hour	L	M

Source: Reference 77, pages 13-16.

Table 4
CONFIDENCE AND RELEVANCE RATINGS--TRANSIT CRIME STUDY FINDINGS (cont'd)

	Conclusion	Confidence	Probable Relevance
32.	Most CAP's were minor, involving indecency	H	M
33.	Most victims were lone individuals	L	M
34.	50% of CAP's are committed on trains in motion between stations	M	H
35.	When the CAP occurred in the station the offender escaped by getting on the train	L	H
36.	Most patrons would feel more secure if they knew emergency assistance could be readily obtained	H	H
37.	Perception of crime on a system has a definite effect on ridership patterns	M	H

Source: Reference 77, pages 13-16.

Regarding the relevance of the findings for the AGT situation, one is particularly noteworthy. That is the occupational employment status of the victim (the last characteristic listed in Table 3). The frequency with which transit employees are victimized is noted in three studies. Since AGT systems are expected not to employ operators and ticket agents, this significant victim category is eliminated. The question then becomes, how much of this crime will be displaced onto patrons? The absence of transit employees in AGT, then, is a two-edged sword. Not only does it eliminate an important surveillance function, but it also creates the potential for displacement. Whereas many previous transit security efforts have been directed at protecting operators, the primary effort of AGT security now becomes one of protecting patrons from each other and from their fear of each other.

Implications for Transit System Design

Table 4 deals more explicitly with the relevance of current findings for the design of transit stations in ways which would enhance the security of patrons. Direct links are drawn between the consensus conclusions of two major transit crime studies and their relevance to security considerations. These links are mediated by the confidence which the authors place in the reliability of the conclusions. Unfortunately, they do not state the criteria which they used in determining confidence and relevance levels. Perhaps at this stage of development, it is sufficient to rely on expert judgment.

However, in the future, explicit criteria might be developed. For example, confidence levels could be determined by criteria such as:

-- Methodological rigor of the source studies.
-- Similarities of transit and neighborhood environments.
-- Age of studies.
-- Number and proportion of studies reporting a similar finding.

It might be more difficult to develop criteria for ascertaining the relevance of a conclusion. However, one criterion might be the reliability of the finding. Other criteria could include:

-- Existence of a countermeasure to deal with the condition.
-- Feasibility of implementing the applicable countermeasure.
-- Cost of the countermeasure.

In Table 3, those transit crime study findings deemed most relevant (high rating) to transit security and countermeasure analysis/planning, and in which high confidence levels were placed, include:

-- Majority of crimes occur in the evening.

-- Robbery victims are lone individuals.

-- Most victims are robbed on the station platform while they await the train.

-- When robbery occurs on the train, it usually occurs while train is in motion between stations.

-- Very few witnesses report transit robberies.

-- Robbers try to escape as quickly as possible.

-- When robbery occurs in station, robber flees to the street.

-- When robbery occurs in train, robber flees at next stop.

-- Robbers rarely pull emergency stop.

-- Most robberies were self-reported by the victims.

-- The shorter the delay between crime and arrival of police, the greater the apprehension rate.

-- Those stations where robbery is highest have high surface (neighborhood) crime.

-- Most victims of battery reported the crime themselves.

-- Most patrons would feel more secure if they knew emergency assistance could be readily obtained.

It should always be remembered when reviewing findings of this type that they are based on the security profiles of conventional transit systems. The extent to which they are applicable to AGT must be assessed. Findings which relate to patron characteristics and patterns of use of the system, such as concentration of crimes in certain time periods, would probably be pertinent to an AGT system operating in a similar environment. However, findings which are dependent on system characteristics would not be applicable to an AGT system if it lacked those characteristics. For example, the relatively low proportion of robberies committed at station entrances and exits in a conventional rapid rail transit system may not hold true for AGT which lacks a characteristic of conventional stations, e.g., attendants.

The types of data presented in Tables 2 through 4 and the analysis suggested by them seem most applicable to a generic methodology for predicting AGT system

station security requirements. That is, at a sketch planning level of detail, they can be used to develop some ideas of what security requirements should be applied in a certain type of city or area. However, to refine those requirements to the level of implementation, based on prospects for effectiveness and applicability of specific countermeasures, will require a site-specific methodology. Such a methodology would incorporate data collection methods and techniques for analysis and prediction applicable to given locality types. Developing a prototype of a site-specific methodology is the focus of this project and is discussed in more detail later in the report.

Chapter 2
TRANSIT, CRIME, AND POLICING RELATIONSHIPS

Overview: 12 Existing Transit Systems

Basic characteristics of 12 major transit systems are presented in Table 5. Included is information regarding environmental characteristics, crime problems, and police characteristics. This information is pertinent to a consideration of the similarities of conventional transit and AGT.

Implications for AGT Systems

The columns on system characteristics, crime problems, and police characteristics represent a prototype of the information needed (at a sketch planning level of detail) to begin drawing implications for security requirements on AGT system stations at the generic level, based on conventional transit information. The logic of the process is quite simple:

1. From the system characteristics column, *isolate those features which are also present in AGT systems* and which are believed to facilitate or impede crime. For example, automated fare collection on PATH; high-speed, semi-automatic rapid rail service on PATCO; and new stations in BART are all similar to AGT system features.

2. *Determine the level and types of crime for those systems sharing characteristics with AGT.* The information contained in this table is suggestive of crime problem differentials among systems, e.g., PATH with its predominance of robbery and assault appears more dangerous than PATCO or BART which seem to experience major problems only with property crimes. However, for a more thorough analysis, more detailed data on crime rates by type should be obtained.

3. *Compare types of policing strategies employed with severity of crimes experienced by those systems with features comparable to AGT.* This process eventually can yield some rough approximations of the effectiveness of variations with one type of countermeasure for the AGT situation.

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORCANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
CHICAGO TRANSIT AUTHORITY (CTA)	SUBWAY/ELEVATED BUS	HIGH-SPEED, SEMI-AUTOMATIC RAPID RAIL AROUND THE CLOCK SERVICE LARGE, 90 MILES OF PASSENGER REVENUE LINE MIXTURE OF OLD AND NEW STATIONS FARE COLLECTION - AUTOMATED AND BY CONDUCTORS—COIN OPERATED TURNSTILES BUSES - LARGE INNER CITY SYSTEM 2500 VEHICLES EXACT FARE	ROBBERY BATTERY ASSAULT INDECENT EXPOSURE CIVIL LAW VIOLATIONS (SMOKING, TRUANCY, AND CURFEW)	CHICACO POLICE DEPARTMENT'S MASS TRANSIT UNIT 239 OFFICERS FOCUS ON SUBWAY CTA SECURITY DIVISION 60 MEN FOCUS ON COMPANY PROPERTY CHICAGO POLICE DEPARTMENT'S DISTRICT COMMANDS HANDLE BUSES	SATURATION - PLAINCLOTHES AND UNIFORMED OFFICERS FIXED POSTS MOBILE POSTS TACTICAL UNDERCOVER TEAMS K-9 CORPS
MASSACHUSETTS BAY TRANSPORTATION AUTHORITY (MBTA)	SUBWAY (TROLLEY) BUS	LARGE, PRIMARILY INNER CITY SYSTEM MEDIUM-TO-HIGH-SPEED SUBWAY AND TROLLEY LINES LIMITED SERVICE 5:55 AM - 12:45 AM WEEKDAYS 5:55 AM - 1:45 AM WEEKENDS OLD STATIONS FARE COLLECTION - CHANGE BOOTHS AND QUARTER COIN. MACHINES BUSES - ABOUT 1200 VEHICLES	POCKET-PICKING VANDALISM INTERNAL THEFT LARCENY	DEDICATED, IN-HOUSE, SWORN POLICE 61 OFFICERS	FLEXIBLE DEPLOYMENT IN PATROL CARS, STATIONS, AND ON TRAINS PLAINCLOTHES STAKEOUTS COMMUNITY RELATIONS

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING (cont'd)

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORGANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
NEW YORK CITY TRANSIT AUTHORITY (NYCTA)	SUBWAY/ELEVATED BUS	4-BUROUGH SYSTEM OF 230 ROUTE MILES - LARGEST IN UNITED STATES AROUND THE CLOCK SERVICE MOSTLY OLD STATIONS FARE COLLECTION - TOKENS SOLD BY STATION ATTENDANTS--TOKEN OPERATED TURNSTILES BUSES - 4,256 VEHICLES	ROBBERY PURSE-SNATCHING FARE EVASION VANDALISM	DEDICATED, IN-HOUSE, SWORN POLICE APPROXIMATELY 3000 OFFICERS CITY POLICE HANDLE BUSES	FLEXIBLE DEPLOYMENT IN STATIONS AND CARS PLAINCLOTHES STAKEOUTS DECOYS LIAISON WITH PROSECUTORS TARGET HARDENING (BULLET-PROOF ENCLOSURES AND SECURITY SHIELDS)
SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY (SEPTA)	SUBWAY/ELEVATED BUS	PRIMARILY INNER-CITY SUBWAY - 24.1 MILES 2150 BUSES AROUND THE CLOCK SERVICE OLD SUBWAY STATIONS SUBWAY ATTENDED BY CASHIER BUSES - EXACT FARE/SCRIP	ROBBERY LARCENY VANDALISM ROWDYISM INTERNAL SECURITY	PHILADELPHIA POLICE DEPARTMENT DEDICATED TRANSIT UNIT - SUBWAY 160 OFFICERS (PLUS 50 DOGS) TRANSIT COMPANY SECURITY DEPARTMENT - 22 MEN INTERNAL AND PROPERTY SECURITY CITY POLICE DEPARTMENT DISTRICT PATROLMEN HANDLE BUSES	FIXED POSTS, MOBILE FOOT PATROLS AND RIDING POSTS - DEPLOYMENT ASSOCIATED WITH CRIME AND RIDERSHIP PATTERNS STAKEOUT, DECOY AND PLAINCLOTHES TACTICS ON AN "AS THE SITUATION DICTATES" BASIS MONITORING (BY TRANSIT COMPANY SECURITY DEPARTMENT)

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING (cont'd)

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORGANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY (WMATA)	SUBWAY/ELEVATED BUS	SUBWAY - UNDER CONSTRUCTION, 4.6 MILES AND 5 STATIONS CURRENTLY OPERATING DOWNTOWN (TO BE GREATLY EXPANDED) LIMITED SERVICE: 6 AM TO 8 PM WEEKDAYS EXACT FARE AND STATION ATTENDANTS PARKING LOTS BUSES - LARGE INNER CITY/ SUBURBAN SYSTEM 2,030 VEHICLES EXACT FARE	SUBWAY - VERY LITTLE CRIME REPORTED SO FAR	DEDICATED, IN-HOUSE SWORN POLICE PLUS SPECIAL POLICE: ABOUT 100 SWORN POLICE AND 67 SPECIAL POLICE LOCAL POLICE DEPARTMENTS HANDLE BUSES	FIXED AND MOBILE PATROLS ON TRAINS, IN STATIONS, PARKING LOTS AND CONSTRUCTION AREAS DEPLOYMENT BASED ON TRANSIT CRIME DATA AND CRIME DATA OF AREAS SURROUNDING STATIONS PLAINCLOTHES USED IF NECESSARY
MASS TRANSIT ADMINISTRATION OF MARYLAND (MTA) (BALTIMORE)	BUS	MEDIUM SIZE - 1021 VEHICLES PRIMARILY INNER CITY - SOME SUBURBAN AROUND THE CLOCK SERVICE EXACT FARE PARKING LOTS	ASSAULT THEFT ROBBERY POCKET-PICKING VANDALISM DISORDERLY CONDUCT	MTA SECURITY FORCE SWORN POLICE 36 MEN CITY AND COUNTY POLICE DEPARTMENTS FOR BALITMORE AND ANN ARUNDEL COUNTIES AND MARYLAND STATE POLICE ON AN AS NEEDED BASIS	GENERAL PATROL OF BUSES IN UNIFORM STAKEOUTS - PLAINCLOTHES PATROL BY CARS OFFICERS ASSIGNED DAILY TO RIDE SCHOOL TRIPPER LIAISON WITH LOCAL POLICE AND SCHOOL AUTHORITIES BUSES EQUIPPED WITH SILENT ALARMS AND 2-WAY RADIOS

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING (cont'd)

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORGANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
PORT AUTHORITY TRANS-HUDSON CORPORATION (PATH)	SUBWAY/SURFACE SEPARATE GRADE	HIGH-SPEED RAPID RAIL SUBURBAN COMMUTER LINE SMALL - 13.9 MILES 13 STATIONS AROUND THE CLOCK SERVICE MIXTURE OF OLD AND NEW STATIONS AUTOMATIC FARE COLLECTION —COIN OPERATED TURNSTILES	ROBBERY ASSAULT THEFT OF COIN CHANCE MACHINES MINOR JUVENILE OFFENSES/VANDALISM	DEDICATED, IN-HOUSE SWORN POLICE 53 PATROL OFFICERS 11 SUPERVISORY OFFICERS 4 DETECTIVES (PART OF A LARGE PORT AUTHORITY POLICE FORCE WITH 1200 MEN)	FLEXIBLE DEPLOYMENT (IN CARS, ON FOOT, ON TRAINS) COMMUNITY EDUCATION PROGRAMS CLOSED-CIRCUIT TELEVISION
PORT AUTHORITY TRANSIT CORPORATION OF PENNSYLVANIA AND NEW JERSEY (PATCO)	SUBWAY/ELEVATED	HIGH-SPEED, SEMI-AUTOMATIC RAPID RAIL SUBURBAN COMMUTER LINE SMALL - 14.5 MILES AROUND THE CLOCK SERVICE MIXTURE OF OLD AND NEW STATIONS AUTOMATED FARE COLLECTION --GATES OPERATED BY MAGNETIC CARD PARKING LOTS	THEFT OF AND LARCENY FROM CARS FARE EVASION VANDALISM	DEDICATED, IN-HOUSE SWORN POLICE 21 MEN PLUS 4 DOGS	FLEXIBLE DEPLOYMENT (IN CARS, ON FOOT, ON TRAINS) STAKEOUTS COMMUNITY RELATIONS CLOSED-CIRCUIT TELEVISION
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT (BART)	SUBWAY/ELEVATED	HIGH-SPEED, SEMI-AUTOMATIC RAPID RAIL SUBURBAN COMMUTER LINE LARGE - 77 MILES LIMITED SERVICE: 6 AM TO MIDNIGHT WEEKDAYS NEW STATIONS - MIXTURE OF ARCHITECTURAL DESIGNS AUTOMATED FARE COLLECTION -- GATES OPERATED BY MAGNETIC CARD PARKING LOTS	THEFT OF AND LARCENY FROM CARS FARE EVASION/TICKET FRAUD VANDALISM INTERNAL THEFT	DEDICATED, IN-HOUSE SWORN POLICE 77 SWORN PEACE OFFICERS PLUS 19 CIVILIANS	FLEXIBLE DEPLOYMENT WITHIN ZONES (IN CARS, ON TRAINS) BASED ON PIN MAPS STAKEOUTS SATURATION - MIXTURE OF PLAINCLOTHES AND UNIFORMED OFFICERS COMMUNITY RELATIONS

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING (cont'd)

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORGANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
METROPOLITAN ATLANTA RAPID TRANSIT AUTHORITY (MARTA)	BUS	MEDIUM SIZE - 735 VEHICLES AROUND THE CLOCK SERVICE PRIMARILY INNER CITY, SOME SUBURBAN SPECIAL SCHOOL TRIPPERS EXACT FARE PARKING LOTS	ROBBERY VANDALISM ASSAULT	IN-HOUSE SECURITY UNIT - 5 MEN	LIAISON PROGRAMS WITH COMMUNITY, SCHOOLS, COURT, PRESS, AND POLICE AGGRESSIVE PROSECUTION REWARDS FOR IDENTIFICATION OF CRIMINALS INTER-PERSONAL RELATIONS COURSE FOR DRIVERS ALARMS, 2-WAY RADIOS, EXACT FARE CONTRACTING WITH OUTSIDE SECURITY FIRM HIRING OFF-DUTY POLICE
SAN FRANCISCO MUNICIPAL RAILWAY (MUNI)	BUS	MEDIUM SIZE - 1074 VEHICLES AROUND THE CLOCK SERVICE INNER-CITY LINES USED BY STUDENTS TO GO TO AND FROM SCHOOL EXACT FARE	ROBBERY ASSAULT POCKET-PICKING PURSE-SNATCHING VANDALISM	SAN FRANCISCO POLICE DEPARTMENT TRANSIT FORCE 9 OFFICERS IN-HOUSE SECURITY SERVICES SECTION II MEN FOR SECURITY OF PROPERTY AND LIAISONS WITH POLICE, SCHOOLS, AND COURTS	TARGET PROBLEM ROUTES RIDE BUSES - PLAINCLOTHES TRAIL BUSES ON MOTORCYCLES SUPERVISE CETA PROGRAM PARTICIPANTS (WHO ARE TRAINED AS TRANSIT SECURITY PERSONNEL)

Table 5
OVERVIEW OF TRANSIT SYSTEMS AND POLICING (cont'd)

SYSTEM	ENVIRONMENTAL CHARACTERISTICS		CRIME PROBLEMS	POLICE CHARACTERISTICS	
	MODE	SYSTEM CHARACTERISTICS		ORGANIZATION/RESOURCE FACTORS	ANTI-CRIME STRATEGIES
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT (SCRTD)	BUS	LARGE - 2,243 VEHICLES AROUND THE CLOCK SERVICE INNER CITY AND SUBURBAN EXACT FARE PARKING LOTS	ASSAULT ROBBERY VANDALISM DRUNK AND DISORDERLY CONDUCT	IN-HOUSE SECURITY DEPARTMENT 46 MEN - PROTECT PROPERTY AND PATROL BUSES	LIAISON WITH POLICE, SCHOOLS AND COMMUNITY OPERATION TEAMWORK - MOVIE STARRING L. A. RAMS SHOWN TO SCHOOL STUDENTS DRIVER-PASSENGER RELATIONS PROGRAM MARKER LIGHTS, NUMBERS PAINTED ON ROOFS, 2-WAY RADIOS, SILENT ALARMS POLICE DEPARTMENT RIDE-ALONG PROGRAM

NOTE: CRIME PROBLEMS LISTED ARE: (1) THOSE STATED BY AGENCY REPRESENTATIVES DURING INTERVIEWS, AND (2) THOSE DEDUCED FROM EXAMINATION OF TRANSIT-RELATED CRIME DATA FURNISHED BY TRANSIT PROPERTIES AND/OR LOCAL POLICE DEPARTMENTS.

ANTI-CRIME STRATEGIES LISTED ARE: THOSE STATED BY AGENCY REPRESENTATIVES DURING INTERVIEWS. IT IS POSSIBLE THAT OTHER IMPORTANT ACTIVITIES IN RELATION TO RESOURCE ALLOCATION (IN TERMS OF MAN-HOURS, FOR EXAMPLE) WERE NOT MENTIONED.

Source: Reference 78, pp. A-3 through A-8.

The problem with this conceptual method, aside from the serious basic considerations of comparability and comprehensiveness of crime statistics, is that the analyst will be dealing with a large number of system, crime, and countermeasure variables in a non-experimental situation. It will be necessary, therefore, to increase the number of transit systems studied to a point where configurations of characteristics will permit some reasonable judgments, about patterns of effectiveness of various countermeasures as related to AGT features.

Unavoidably, logical speculation about the probable links among AGT features, countermeasures employed, and crime problems will be part of the process. However, the process should be viewed as a cumulative one which will become more refined with the addition of more elements of greater reliability. At the minimum, it should provide useful background for (1) planned evaluations and (2) site-specific predictions of security requirements for particular AGT stations, i.e., reliance on local input on countermeasure desirability and past record of effectiveness in the target area.

AGT Characteristics and Crime Potential

Another way of relating AGT characteristics to crime potential is to isolate particular features within ranges pertinent to the parameters of a feasible system and then to estimate relative risk within each feature for each system type (77, page 21). Table 6 depicts three types of AGT systems which have been analyzed in this way. The authors identified 19 features besides vehicle size, station location, and crime rate in the surrounding neighborhood for analysis. These are:

1. Station level.
2. Access to guideway from station.
3. Location and function of booths.
4. Sight lines in stations and illumination levels.
5. Fare collection systems.
6. Orientation of seating.
7. Vehicle identification.
8. Automation override provisions.
9. Communication to and from vehicles.
10. Door openings and closings override provisions.
11. Emergency stop provisions.
12. Emergency escape provisions.
13. Internal surveillability.
14. Access to guideways between stations.
15. Identification of guideway segments.
16. Everything having to do with collateral sites.
17. On-board emergency detection systems.
18. The entire list of emergency procedures.
19. Car identification by central control.

Table 6
CHARACTERISTICS OF THREE HYPOTHETICAL AGT SYSTEMS

Characteristic	Small	Medium	Large
1. Capacity (people)	4-6	6-18	30
2. Guideway Length (miles)	300	150	100
3. Headway (seconds)	0.5	3-10	10-20
4. Number of Stations	200	100	50
5. Waiting Time (minutes)	0-1	2-5	2-5
6. Service	Demand-Responsive	Scheduled/ Demand-Responsive	Scheduled
7. Average Vehicle Occupancy (people)	1.3	4	10-15
8. Guideway Characteristic	Mostly Aerial	All Grades	More Underground
9. Number of Vehicles	1000's	1000	500

Source: Reference 77, page 20.

The ensuing analysis indicated that the small AGT system has the following security advantages:

-- Shortest proposed waiting time.

-- Platform might be amenable to design allowing patrons to wait and ride only with those whom they know.

-- Low occupancy levels when riding.

-- Properly designed elevated guideways (transparent ways).

A disadvantage of the small AGT system is that patrons will usually enter alone. Another security disadvantage will be present when a large proportion of the guideway is at-grade, thus making illegal access probable. In that small systems mean great amount of guideway and large number of stations and vehicles, they also pose security problems. The inclusion of between-station emergency stop capabilities would also pose a patron security problem.

The analysis yielded conclusions at the same general level for the medium and large AGT systems. The medium-size system involves a substantial number of risks to security. These include:

-- Increased length.
-- Increased headways.
-- Increased waiting time.

-- Likelihood of strangers as co-passengers.
-- Access and escape routes to different grades.
-- Possibility of on-board automation.

Risks are also associated with the large AGT system. However, it also has security advantages over the other two systems, i.e., a smaller number of stations and vehicles and a shorter guideway. Disadvantages include:

-- Longer waiting time.
-- More underground portions.
-- Intermediate stops.
-- Larger stations.
-- Increased number of people, schedules, and waiting time.
-- Might lead to frustrations during rush hours resulting in assaults and batteries.

This type of characteristics analysis could be extended to the site-specific level and expanded to include similar evaluations of countermeasures designed to deal with the security deficiencies of a given AGT system and station type.

Chapter 3
CHARACTERISTICS OF AGT ENVIRONMENTS

Automated guideway transit is a form of transportation in which fully automated vehicles operate along a fixed guideway having an exclusive right-of-way (59). The electrically powered vehicles can have capacities ranging from four to 100 passengers, and may be used as either single units or linked together to form trains. The relatively small size of these traveling units, compared with conventionally guided transit, is intended to permit a higher level of service, especially during non-peak periods. The increased service would be a product of either shorter headways or service provided in direct response to passenger requests (demand-responsive service). It is common for these systems to provide lobby-type stations, including level platform boarding, and either coordinated vehicle and station doors or some type of train screen. Since vehicles are unattended, fares, if charged, are collected in the stations.

There are three basic classifications of AGT systems (59). These include shuttle loop transit (SLT), group rapid transit (GRT), and personal rapid transit (PRT). These three categories generally reflect decreasing vehicle capacity and increasing route flexibility. Tables 7 and 8 summarize a number of key system, operating, and service characteristics for the three AGT modes, and compare them with conventional rail modes.

Shuttle Loop Transit

Shuttle loop transit (SLT) is the most simplistic form of an AGT system. The route configuration includes no operational switching capability. This implies that vehicles either move back and forth along a single guideway, serving as the horizontal equivalent of an elevator, or circulate around a closed path. In both the shuttle and loop systems, vehicles may vary in size and may be operated independently or joined together in trains. An example of the shuttle system is the Tampa Airport guideway system, which moves passengers from one terminal to another. An example of the loop system is the monorail in Disneyworld. Although numerous examples of SLT systems exist, they all operate within controlled environments such as airports or recreational settings. None of the systems have been developed in a normal urban environment which serves the general public (65).

Table 7
GENERIC CHARACTERISTICS OF GUIDEWAY TRANSIT MODES

	AGT				Rail				
	SLT	GRT	AGRT	PRT	Commuter	Rapid Rail	LRT Exclu-sive Right-of-Way	LRT Semi-Exclusive Right-of-Way	Streetcar
System Characteristics									
Station Spacing--Miles	<2	<2	<2	<2	.5-2	.5-2	.5-2	<.5	<.5
Right-of-Way (mixed, semi-exclusive, exclusive)	E	E	E	E	E	E	E	SE	SE
Guidance (tracked, ubiquitous)	T	T	T	T	T	T	T	T	T
Branching (yes, no)	N	Y	Y	Y	Y	Y	Y	Y	Y
Power Supply (self-contained, external)	E	E	E	E	SC/E	E	E	E	E
Stations--Platform Height (low, high-level)	H	H	H	H	H	H	H/L	H/L	L
-- Access (uncontrolled, controlled, train screen)	TS	TS	TS	TS	C	C	U/C	U/C	U/C
Control (automated driverless, automated with attendant, signalized, manual visual)	AD	AO	AO	AD	AA/S	AA/S	MV/S	MV/S	MV
Trip Length Limits (finite, none)	F	N	N	N	N	N	N	N	N
Vehicles--Capacity	50-100	20-40	8-20	4-6	200	200	200	200	200
-- Ratio of Seated to Total Capacity	0.1	.33	1.0	1.0	1.0	.33	.33	.33	.33
-- Cars per Operating Unit	1,2,3	1,2,3	1	1	8-10	8-10	4-6	4	1,2,3
-- Assembly of Consists (auto, semi-auto, manual)									
Operating Characteristics									
Capacity--One-Way, Single-Lane--1,000 PPH	<18	3-18	3-18	3-8	3-18	8-18	8-18	3-18	.18
Dispatch (schedule, demand)	S	S/O	S/D	D	S	S	S	S	S
Stations (one-line, off-line)	On	Off	Off	Off	On	On	On	On	On
Routing (all, skip, express, origin-destination)	A	E	E	O-D	SE	A	A	A	A
Minimum Safe Headway--Seconds	30	7.5	3	1	30	30	30	30	30
Service Characteristics									
Schedule Speed--mph	15-30	15-30	15-30	20-40	>20	>20	>20	10-20	<10
Frequency of Arrival (minutes)	1-10	1-10	1-10	<10	>10	1-10	1-10	1-10	1-10
Occupancy (selected, group)	G	G/S	G/S	S	G	G	G	G	G
Intra-Modal Transfers (yes, no)	Y	N	N	N	Y	Y	Y	Y	Y
Standees (yes, no)	Y	Y	N	N	Y	Y	Y	Y	Y
Weather Protection (controlled, protected, exposed)	C	C	C	C	C	C	P	P	P/E
Examples	Tampa SEATAC	OFW MGNTN	AGRT Prgm	CVS Cabinen Taxi	BART C-NW	WMATA	S.F. MUNI		Phil.

Source: Reference 65.

Table 8
KEY SERVICE CHARACTERISTICS FOR GUIDEWAY TRANSIT MODES

Modal Group	Generic Mode	System Characteristics: Station Spacing (Miles) <.5	.5-2	>2	Operating Characteristics: Line Capacity (PPHPD, One Lane)(1) <3,000	3,000-8,000	8,000-18,000	>18,000	Service Characteristics: Schedule Speed (MPH) <10	10-20	>20	Frequency (Minutes, Minimum) <1	1-10	>10
AGT	SLT	0	0		0	0	0			0	0		X	
	GRT	0	0			0	0			0	0		X	
	AGRT	0	0			0	0			0	0		X	
	PRT	0	0			X					X	0	0	
Rail	Commuter Rail		0	0		0	0				X			X
	Rapid Rail		X				0	0		0	0		X	
	LRT-Excl. ROW		X				0	0		0	0		X	
	LRT-Semi-Excl. ROW	X				0	0			X			X	
	Streetcar	X				X			X				X	

(1) Persons per hour, peak direction.

X = Only one service level available.
0 = More than one service level available.

Source: Reference 65.

A minimal switching capability is desirable on SLT's in order to permit the rerouting of vehicles in the event of equipment failures and also to allow access to maintenance areas. The lack of an operational switching capability means that all stations must be located on-line and passengers must transfer if their trip involves more than one shuttle or loop segment. Transfer accommodations typically provide comfortable, controlled environments which minimize the inconvenience associated with transferring.

SLT vehicles typically can accommodate from 50 to 100 passengers, including both seated and standing capacity. Cars can be operated independently or joined together to form trains, usually not exceeding three cars in length.

Stations are usually spaced between one-half and two miles apart and may be located above, below, or at grade. Typically, trains stop at all stations and only operate according to schedule. The minimum safe headway between vehicles or trains is about 30 seconds, and vehicles are designed to travel at speeds of approximately 15 to 30 mph. The maximum platform waiting time should range between one and 10 minutes (65).

Group Rapid Transit

Group rapid transit (GRT) systems differ from the SLT concept because they possess an operational switching capability. This permits off-line stations and the branching of routes. Operationally, GRT systems are able to provide more complex routing arrangements, including local express service and service on multiple routes which can bypass some or all intermediate stations. The GRT branching capability is designed to eliminate the need for many passenger transfers within a GRT system. Similar to SLT, GRT vehicles involve multiple occupancy, permit standees, and may be operated in trains. Individual cars have a capacity ranging from six to 50 passengers and may be operated according to schedule or on demand. The use of off-line stations permits operational headways as short as 15 seconds for existing GRT equipment (65).

There are two existing GRT systems in the United States, including the one in Morgantown, West Virginia, and the Airtrans system at the Dallas/Fort Worth Airport. In Morgantown, the stations are located above grade and trains operate on an exclusive elevated track. In contrast, the Airtrans operates at different grades along its route. Typically, GRT systems have stations located between .5 and two miles apart.

Personal Rapid Transit

Personal rapid transit (PRT) refers to an AGT concept in which the private use of a small automated vehicle is available to the passenger upon demand. Under computer control, vehicles switch at guideway stations to provide a non-stop trip from origin to destination within a gridded network. This origin-destination service, available upon demand in a private conveyance, clearly distinguishes PRT from other AGT modes (65).

The PRT concept consciously imitates the automobile in an attempt to provide a high level of service and attract maximum patronage. However, since occupancy levels will not be much higher than for automobiles, automobile type headways of one to two seconds are necessary in order to achieve adequate line capacity. The technical challenge involved in achieving these headways with driverless equipment, coupled with the complex software required to manage large numbers of vehicles operating in a network, require a large research and development effort if this concept ever is to be realized. Critics of the concept question the cost and intrusiveness of the extensive network of guideways and stations which would be required, suggesting that it is pointless duplication of the existing highway and parking network. The only prototypes for this type of system are the Cabinentaxi in Germany and the CVS in Japan. There are no systems in passenger service.

Each PRT vehicle is designed to accommodate between four and six passengers, all seated. Occupancy could be selective so that no person would be traveling with a stranger and the vehicle would not stop until it arrived at the selected destination. PRT stations would be at a substantially reduced scale than SLT facilities and would tend to be located in closer proximity to one another.

Composite AGT

In the subsequent discussion, a generalized form of AGT, primarily incorporating characteristics of SLT and GRT, will provide the framework for analysis. In other words, it will be assumed that the composite system operates on an exclusive guideway and that vehicles are automated and driverless. Vehicles could be operated as independent units or linked together to form trains; there would be group occupancy of vehicles and standees allowed; and the capacity of a single car might range from four to 100 people. The system would provide the flexibility to be operated on a schedule during peak periods and on demand during off-peak hours.

Stations would offer a controlled environment and could be located above, below, or at grade. Most commonly, stations would occur above grade and would be reached via escalators, elevators, and stairways. Access to stations could be controlled or uncontrolled, depending, at least in part, upon whether a fare is charged. Optimally, AGT stations would be located off-line, so that trains could pass vehicles already standing in stations. In this way, routing would permit express service so that stations could be bypassed.

Comparative Analysis: AGT Versus Washington Metro

For purposes of comparative analysis, the Washington, D.C., Metro, a heavy-rail transit system, is used as a "control environment." It is contrasted to the composite form of the AGT systems, reflecting characteristics of both the shuttle loop and group rapid transit systems. The features unique to personalized rapid transit systems are not specifically addressed.

Physical and Operating Characteristics

Because of its modern facilities and limited operating characteristics, Washington's Metro is not particularly representative of heavy-rail transit in the United States. However, these modern features do reflect many of the qualities which have been proposed for AGT systems. One of the main differences between facilities for the Washington Metro and AGT systems is the difference in the number of passengers which each is designed to accommodate at any given time. On Metro, the single direction line capacity per hour during peak periods ranges between 21,000 and 42,000 passengers. The majority of GRT systems* are aimed at a more intermediate capacity, ranging between 10,000 and 30,000 passengers per lane per hour.

Although the physical characteristics of stations would be somewhat similar, operating characteristics of the two transportation forms are more varied. AGT systems could be operated on a schedule during peak hours and on demand during off-peak periods. In contrast, the Washington Metro operates according to a schedule at all times. Although both systems serve only a limited area, AGT's can provide point to point service in addition to the collection/distribution function, such as that provided by local buses for Metro. Metro is a radial line-haul (express) system with minimal branching capabilities, whereas AGT's might operate within a complex, gridded network.

AGT vehicles are designed to accommodate capacities typically ranging from four to 100 passengers, including standees. Metro cars, in contrast, can seat 80 persons and can accommodate an additional 128 to 160 standing passengers. AGT vehicles can travel independently or linked together to form trains, typically no longer than six cars. Metro operates with between four and eight cars per train during peak demand periods, and with two to four cars per train during off-peak hours. One transit employee is necessary to operate a Metro train, but AGT vehicles are fully automated, not requiring any driver. Security on the AGT vehicles themselves would be provided by two-way communication and alarm systems. Similar systems are provided on the Washington Metro, but are augmented by police operations.

Station Facilities Design

The Washington Metro includes a variety of on-line station facilities. They range from sub-grade controlled environments to stations above grade which are covered, but not enclosed. The average platform length in a Metro station is 600 feet. In contrast, platform lengths for AGT systems are designed to range from 20 feet to 200 feet. These differences in size reflect the capacities of the two systems and also the branching/docking technology. Compared to the long, linear waiting area in Metro stations, AGT stations are envisioned as being more like elevator lobbies.

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* This has been generalized to include SLT's.

AGT stations, both off-line and on-line, may be found above, below, or at grade, similar to those on the Washington Metro. However, due to the cost of sub-grade installations, most systems are designed to operate above grade. Access to AGT stations would be provided by stairs, escalators (optional), and elevators for the handicapped. Stations could be incorporated into buildings or could be freestanding platforms with guideways going on one or both sides of the station. Although most AGT stations are envisioned as enclosed areas providing controlled environments, they may also include open air waiting platforms. AGT stations might also permit boarding at two different levels, if the station were at an interface between two non-connecting lines. This situation might prevail when there are multiple shuttle or loop routes.

Station Operations

Access to above-grade Metro stations also is provided by stairs, escalators, and elevators. They are island stations with tracks running on both sides of the boarding platform. Entry to the platform area is controlled through the use of fare gates at the ground level. Also, there is a single booth from which one or more transit employees monitor the operation of the equipment and the people entering and exiting the system. The size of the public area at the ground level of the station is kept to a minimum and contains the fare card machines and automatic newspaper machines. During periods when the Metro is not operating, access to the public areas and platforms is prevented through the use of high metal gates.

The maximum waiting time expected on AGT systems would be between one to five minutes, dependent upon the nature of the system. The smaller the vehicles, the shorter the anticipated waiting time. On the Washington Metro, average waiting times can be as short as two minutes during rush hour and up to 10 minutes at other times. The principal form of security envisioned for AGT stations is closed circuit television monitors in the entry and platform areas. In the larger systems, it might be possible to have a single station attendant; however, this eliminates some of the benefits of a fully automated system.

In the Washington Metro, closed circuit television cameras monitor the entry points and the platform area. In addition, there is a station attendant who can observe problems in the public areas of the station and also check for fare evasion. The platforms themselves have been designed to maximize visibility, thereby minimizing criminal opportunities. In addition, there is a public address system throughout the system and public telephones are provided in the unrestricted areas of the station.

In general, AGT stations would be very similar to those of the Washington Metro, except on a smaller scale. In one respect, the smaller area and the shorter waiting time would be advantageous from a security viewpoint; however, the absence of transit personnel could be a major detriment. In both systems, fare collection is automatic so there is no need for personnel to sell tickets and collect fares.

Station Environments

An AGT system would have more, but smaller, station facilities than a heavy rail transit system such as the Washington Metro. Most AGT stations would be spaced between one-third and one-half mile apart. The Washington Metro, on the average, will have stations spaced over one mile apart; however, the downtown stations are more reflective of the spacing expected with AGT's. Basically, AGT stations would be set in environments similar to those of the Metro systems. However, a consistent difference might be that AGT's would occur more frequently in smaller-scale neighborhood settings. The stations could be either freestanding islands or incorporated into buildings. Thus, the setting of AGT stations would range from large commercial and institutional activity centers to small neighborhood locations. Since it is expected that there would be a greater number of neighborhood stations than in Metro, it would be useful to adapt security provisions in AGT stations to the surrounding area and population.

Chapter 4
TRANSIT STATION ENVIRONMENTS

Transit station environments are addressed in this chapter from both an *internal* and an *external* viewpoint. The internal environment is discussed in terms of design and use factors affecting transit station crime opportunities, emphasizing AGT station characteristics. The external environment is considered in terms of the surrounding neighborhoods, and their socioeconomic and crime characteristics, within which transit stations are set.

Transit Station Crime Opportunities

The opportunity for crime in any environment is identified by the Westinghouse Electric Corporation in its *Crime Prevention Through Environmental Design* series (36) as a function of four characteristics: target, risks, effort, and payoff.

Based upon these characteristics, an environmental assessment package, Crime Opportunities: Targets, Risk, Effort, Payoff Analysis (OTREP analysis), has been developed to determine the crime opportunity in a given environment, relative to a control setting. Using this analytical technique (described further in Chapter 8), the parallels between AGT stations and conventional transit stations can be drawn.

The first step in the OTREP analysis is to identify the context of the site—the types of buildings in the surrounding area, typical behaviour settings, user characteristics, and potential offender populations.

As mentioned earlier, it would be expected that AGT stations would be located in neighborhood settings with a greater relative frequency than heavy-rail transit stations. The implication of this is that AGT stations would more frequently be surrounded by lower density residential development and commercial uses having a greater neighborhood orientation. As a result, daily activity cycles would be less dramatic than in areas primarily serving employment or retail centers. At any given station, transit user characteristics would reflect the neighborhood social profile.

Targets

As in conventional transit, the primary targets for criminal activity in AGT systems would include money, private property, public transit property, and people themselves. In contrast to some transit operations, there would be no opportunity for toll booth robbery because of the automated fare collection.

Risk

The risk a transit rider assumes in the use of public transportation is a cumulative function of the risks encountered in the environment surrounding the transit station, within the transit station, and on transit vehicles themselves. With respect to the surrounding environment, OTREP analysis associates risk with the amount of pedestrian and automobile traffic in the surrounding area, the type, condition, and design of land-uses in the surrounding area, and the extent of police activity. Within the transit station itself, risk is associated with the number of people within the station, their behavior patterns, and the general design of the stations. Furthermore, risk is associated with the nature and scale of policing operations and the visibility of police.

Effort

The effort required to commit a crime will definitely be a consideration for most criminals. This will be one factor weighted against the prospective payoff. The degree of effort is often associated with the ''hardness'' of the targets. In other words, the materials which serve as targets for criminal activity can be made less attractive through a variety of techniques, such as putting bars or alarms on windows, or locks on doors.

Payoff

Closely associated with target, the payoff reflects the level of anticipated and actual return to a criminal for his actions. In automated systems, where people and transit property represent the major criminal targets, payoffs typically are not large per incident. The target generating the most sizable payoff would most likely be the fare card machines. Nonetheless, these could be designed to be vandal resistant (36).

Cognitive Factors

In addition to the environmental characteristics which have criminal implications, there are cognitive factors associated with the transit environment. These are associated with the news media and the publicity associated with various transit crimes and crime prevention efforts. Furthermore, there are environmental signs, such as burgler alarms or security patrols, which also have a cognitive effect upon the criminal. Finally, environmental characteristics such as cleanliness, maintenance, and attractiveness of the environment, also have security implications.

Relative to conventional transit environments, the area surrounding AGT stations may be more defensible only because of the typically smaller scale, neighborhood orientation. In some respects, the pedestrian and automobile activity in the surrounding area would serve as a self-policing influence. Furthermore, if AGT stations were carefully designed, opportunity for crime could be minimized. If developed at grade or visibly above grade, law enforcement patrols could police the station as part of the normal beat. The effort required to commit crimes in AGT systems versus conventional transit would not be substantially different, however, the fear of apprehension would be significantly reduced because of the absence of police patrols on trains and in most stations. Therefore, target exposure and general crime opportunity might be greater in AGT systems. In terms of payoff, there would be no substantial difference between AGT systems and conventional transit.

Neighborhood Environs of Transit Stations

The proposition that crime on transit systems replicates the crime which occurs in the neighborhoods where these systems operate is entirely sensible. The literature, however, only occasionally addresses the issue of crime and security in transportation and its relationship to crime and security in surrounding neighborhoods. The data available suggest that there is, indeed, a strong relationship between neighborhood crime and transit crime and, in fact, that security concerns on transit tend to mirror those occurring in surrounding communities. This section provides a qualitative assessment of the literature which addresses the relationship between crime on transit and crime in neighborhoods. It reviews generally the relationship between the broad conceptual basis for crime prevention activities in neighborhoods and the possible adaptation of these concepts to the transit environment.

Comparison of Transit Crime with Street Crime

In comparing transit crime with street crime, Siegel, et al., (78) reached the following findings, based on an extensive literature survey, site visits, and communication with transit police and security officials:

-- Transit crime reflects the environment; increases in transit crime parallel increases in street crime.

-- Criminal transit acts generally occur in public, making them more detectable. Thus, surveillance and preventive patrol may have greater deterrent effect in transit than in neighborhoods.

-- The enclosed transit system enhances police visibility.

-- Transit systems are amenable to the construction of physical barriers or changes in operations to prevent some criminal activity (e.g., automatic fare collection, closing parts of stations, decreasing headway, limiting access to certain stations).

-- Large movements into and out of stations may limit ability to deter and apprehend.

In other research, Shellow, et. al., (74) found that high-crime stations tend to be located in high-robbery environments. In general, high-crime areas tend to correspond with high-unemployment areas (Shellow (74) and Boydell (5)). Also, most transit offenders, similar to offenders in general, live within the same police districts in which their crimes are committed (74).

Harris (27) concurs with these findings. He holds that the general crime statistics of an area are one of the important variables to consider when developing design criteria for transit systems. Harris noted that ''the physical site of the subway station can influence to a great extent the amount of C/H (crime and harassment) activity within the station'' and further stated:

> ''Land-use of the area where the station is located can be an important factor connected with crime rates. Poorly maintained bars, flophouses, and poor residential areas will probably cause a subway station to have many problems with drunks, loitering, muggings, etc. In comparison, a subway station located near a park or upper-class residential area might have more problems with robberies, rapes, assaults, etc. Knowledge of what location, conditions, and other variables contribute in reducing or increasing types of C/H in stations and trains must be understood.'' (27:30).

Transit Crime and Neighborhood Socioeconomic Conditions

Boydell (5) found correlations between crime and city population characteristics. Cities with high percentages of their populations between ages 15 and 35 tended to experience higher rates of robbery and aggravated assault. An inverse relationship was found between the levels of education and income of the population and crime rates; a correlation was also found between the crimes of robbery and aggravated assault and population size and density. While Boydell did not specifically consider crime and security in transit systems, it logically follows that the same population characteristics associated with the occurrence of crime in a general area would also be associated with the occurrence of crime in and around transit stations located within such an area.

Mulvihill and Tumin (54) find that high-residential densities, deteriorating physical conditions, and generally a low quality urban environment are usually associated with other features of poverty and deprivation, and may be causally associated with violent behavior. This finding supports the renewed emphasis on the crime-linked-to-environment theories of Shaw and McKay (72).

Although the causes of crime and delinquency continue to be debated, a recent trend among social scientists has been to reconsider and give considerable weight to the theories of the Chicago School, spearheaded by Shaw and McKay in the 1940s. The Chicago School supports the hypothesis that crime and delinquency are highest among residents of poor and industrialized inner city areas where environmental conditions are substandard. As the characteristics which define the occurrence of crime and delinquency are analyzed, it is increasingly apparent that the high rates experienced by inner city urban areas relate directly to the living conditions found in those areas.

Cloward and Ohlin (14) support these notions with respect to delinquency by stating that:

> ''Delinquency is not, in the final analysis, a property of the individuals, or even of subcultures; it is a property of the social systems in which these individuals and groups are enmeshed. The pressures that produce delinquency originate in these structures, as do the forces that shape the content of specialized subcultural adaptations. The target for preventive action, then, should be defined, not as the individual or group that exhibits the delinquency pattern, but as the social setting that gives rise to delinquency.''

The former Boston Police Commissioner, Robert J.D. Grazia, concurs by stating:

> ''Most of us are not telling the public that there is relatively little the police can do about crime. We are not letting the public in on our era's dirty little secret: that those who commit the crime which worries citizens most—violent street crime—are, for the most part, the products of poverty, unemployment, broken homes, rotten education, drug addiction and alcoholism, and other social and economic ills about which the police can do little, if anything.'' (73).

It seems clear that there is a very definite relationship between neighborhood environmental conditions, crime, and security on transit systems. That this relationship is generally ignored may suggest why crime continues on transit systems regardless of resources increasingly devoted to the development and implementation of countermeasures.

Part II
STATION SECURITY COUNTERMEASURES

Chapter 5
COUNTERMEASURES FOR CRIME REDUCTION

For purposes of this report, "countermeasures" are considered to be synonymous with "station security requirements." Thus, the definition of countermeasures is quite broad. It includes any feature of a transit system which is intended to reduce crime or which serves that purpose. Consequently, countermeasures may be designed for security or emergency purposes, i.e., closed circuit television monitors, alarms, etc. or they may be a design feature, such as open sight lines or an operational procedure, such as short headways or direct routing. Sometimes the security implications of the design feature will not become apparent until the feature has become operational. For example, the surveillance deterrent provided by manned newstands were not purposely planned or even recognized when they were first established. Nonetheless, they can serve a major function in surveillance.

Countermeasure Inventory

Five basic categories of countermeasures are applicable to transit systems:

-- Police deployment strategies.
-- Electronic and mechanical communication and observation devices.
-- Design features.
-- Selective operating procedures.
-- Support activities.

These countermeasures serve to reduce crime or the perception of crime in one of three ways. They are useful in deterring the execution of a crime, thwarting a crime in progress, and/or apprehending an offender after a crime has been committed. Typically, a countermeasure serves more than one of these purposes.

Transit crime countermeasures have been inventoried in a number of previous studies (10, 28, 30, 68, 69, 74, 76, 77, 78, 87). A composite inventory of station security countermeasures, based upon a review of this literature is given in Table 9. The wide range of crime reduction measures potentially available is clear. The classification scheme by which the various countermeasures in Table 9 are categorized is drawn from the most recent and thorough of these inventories (30).

Table 9
INVENTORY OF STATION SECURITY COUNTERMEASURES

Countermeasure Type	Classification I	II	III
I. Design-Related Countermeasures			
Lighting	B	E,F,H	J
Open Site Design	B	E,F,H	J
Climate Control	B	E,F	K
Transparent Barriers and Adaptive Space	B	E	K
Target Hardening	A,B	E,F	J
--Bullet-proof Enclosures and Security Shields			
--Vandal-resistant Windows and Seating Material			
--Graffiti-resistant Surfaces			
--Fare Box Hardening			
Traffic Volume Control	A	E	K
Access Control (Gates and Barriers)	A,B	E,H	K
--Single Exits			
Land-use Considerations	D	E,F,G	J
Guideway Design	B	G	J
--Elevated System			
--Barriers and Fences			
Provision of Convenience Services	B	E,I	J
--Individual Facilities			
--Eliminate Station Restrooms			
--Transluscent Doors			
Attractive, Clean Environment	B	I	J,L
Tamper-proof Observation Booth	B	E	K
II. Electronic/Mechanical Communication and Security Devices			
Closed Circuit Television (CCTV)	A	E,F,H	L
--Constant Monitoring			
--Alarm Activated			
--Video-recording			
--Dummy Cameras			
Alarms	A	E,F,I	L
--Non-voice			
--One-way			
--Two-way			
--Intrusion Detection			
--Silent			
--Line Supervision Devices (Alarms to Protect Alarms)			

Table 9
INVENTORY OF STATION SECURITY COUNTERMEASURES (cont'd)

Countermeasure Type	Classification I	II	III
II. Electronic/Mechanical Communication and Security Devices (cont'd)			
Voice Monitors	A	E,F	L
Public Address System	A	E,F,H	L
Radios	A	E,F,	
--One-way			
--Two-way			
Emergency Phones	A	E,F,H	L
--To Police			
--To Transit Authorities			
--Transit Personnel to Police			
Personal Walkie Talkies (Transit Personnel)	A	I	L
Televiev Alert System (Coordinated Network of CCTV, Emergency Telephones, Publicly Activated Alarms)	A	E,F,H	L
Metal Detectors	A	E	K
Automated Vehicle Monitoring	A	F	L
Prevention of Fare Evasion	A,C	E,I	L
III. Personnel and Police Operations			
Police Patrols	C	I	L
--Uniformed Patrols			
--Plainclothes Patrol			
--Stakeout/Decoys			
--Saturation Patrols/Random Patrols			
--Canine Units			
--Tactical Undercover			
--Deployment: Fixed Post; Mobile Post; Flexible Deployment in Patrol Cars, Stations, Trains; Deployment Based on Transit Crime Data and Area Crime Data			
Aerial Surveillance	C	I	L
Presence of Transit Personnel	C	I	L
Prescreen Riders (Selective Search)	A,C	E,I	L
IV. Selective Operating Procedures			
Skipping Stops	C	I	K
Eliminating Runs	C	I	K
Reducing Headways (Reducing Number of Cars and Minimizing Waiting Times)	C	I	K

Table 9
INVENTORY OF STATION SECURITY COUNTERMEASURES (cont'd)

Countermeasure Type	Classification I	II	III
V. Support Activities			
Transit Employee Education in Human Relations	C	I	L
Liaison Programs	C	I	J
--Schools			
--Courts			
--Prosecutors			
Community Relations	C	I	J
Job Programs	C	I	J
Local Improvement Association	C	I	L
Local Monitoring Programs	C	I	L
Media Cooperation	C	I	J

KEY

Classification I: A - D (Countermeasure Origin)

- A: Hardware/Device-related
- B: Station/Vehicle Design-related
- C: Personnel/Operations-related
- D: Land-use/Context-related

Classification II: E - I (Interfaced Component of Transit System)

- E: Station Design
- F: Vehicle Design
- G: Guideway Design
- H: Collateral Site Design
- I: Operations Features

Classification III: J - L (Operational Features of Countermeasure)

- J: Passive
- K: Semi-active
- L: Active

Source for classification key: Reference 30

A comprehensive security strategy, involving the coordination of a variety of individual countermeasures, must be flexible in order to adapt to future changes in a transit system. These changes could be associated with the nature of crime, such as increases or decreases in the rate or type of crime, ridership, or the physical and operating characteristics of the system.

A brief review of the five basic countermeasure categories is given below.

Police Deployment Strategies

Police deployment strategies include the use of uniformed and plainclothes officers and of stakeout and decoy operations. The basic rationale underlying the use of police deployment strategies is that they are believed to serve a deterrent function; the presence or expected presence of police officers will keep potential offenders from committing crimes because of the risk of apprehension. Thus, a full force of police officers need not be maintained at all times. The existence of a ''phantom effect'' serves as a deterrent to criminal activity even when the police are not present. For example, periodic saturation patrols have lowered the crime rate for up to eight months after normal policing techniques have been resumed (11).

Attitude surveys have shown that, from the perspective of the transit-riding public, police patrols are felt to provide the best protection from crime on transit. The presence of uniformed police has been shown to deter criminal activity and to alleviate transit riders' fear. The practicality of relying upon extensive police patrols for security in AGT systems is questionable. As conceived, AGT systems would minimize labor needs; there would be no need for personnel to man each AGT facility or vehicle. Therefore, maintaining a large security force to police each station is contrary to the original AGT concept. Furthermore, the cost of this arrangement would be prohibitively expensive.

Thus, instead of full-scale police operations, random police deployment, interfaced with other crime reduction countermeasures, seems to be a practical and effective strategy. If used, the intensity, location, and patterns of police deployment should be varied, in order to maximize the benefits of the phantom effect.

Design Features and Target Hardening

Incorporating design features into the physical structure of transit stations and systems is the most fundamental form of countermeasure. Improved lighting and visibility provided by the use of transparent materials and illumination of hidden areas are two such design approaches. Other techniques include minimization of structural columns in order to open up sight lines, thus facilitating surveillance; concentration of passengers in waiting and circulation areas; and closing stairways and escalators during off-peak hours. Specific areas within stations that require

special attention to security during the design stage include entryways, both in number and location; platforms; restrooms; fare card machines and gates; and the area surrounding the transit station.

Good lighting, both in and around transit stations, should be basic to station design. Lighting is a deterrent to crime because it increases the likelihood that a criminal act will be observed and, therefore, increases the likelihood of apprehension. Good lighting also permits potential victims to anticipate and avoid potential crimes.

Another basic requirement of newly developed transit stations is an open design. This eliminates locations where criminals can hide and maximizes sight lines, thereby improving visibility and facilitating surveillance by security and transit personnel. Climate control is another design feature which is believed to help prevent assault and batteries. In general, a controlled climate makes the transit environment more comfortable for users and, in turn, lessens the frustration associated with delays or crowded conditions. One negative aspect of the controlled environment is that it could provide an attractive refuge for derelicts.

To prevent loitering, access control is necessary. The overall objective should be to minimize the station area open to the general public. This would restrict access to most station areas to fare-paying customers. Overall, it is desirable to concentrate passengers within any given station area (while avoiding overcrowded conditions), in order to maximize the opportunity for self- or group-policing and observation. To avoid having transit passengers widely scattered over a platform, transparent, movable barriers have been introduced as a means of adapting station size to passenger demand.

In addition to basic design characteristics, the materials from which transit station property is constructed can be made of vandal resistant materials. This security approach is described as "target hardening," and it is a common technique used to deter vandalism. For example, bullet-proof glass, seat coverings which resist tearing and marking, and wall surfaces which are not easily defaced are target hardening techniques. This approach may also refer to the construction of burglar-resistant fare card machines.

Communications and Surveillance Devices

Several kinds of surveillance devices and alarms, both electronic and mechanical, are being used in rapid transit stations. These include such features as closed circuit television monitors, emergency telephones, signals and alarms (both one-way and two-way), and public address systems. The rationale behind the use of these techniques is that they will deter the offender from committing a crime. They also may thwart actual commission of a crime and assist in the apprehension of criminals.

In order to be an effective security measure, it is essential for technological devices to be interfaced with transit police operations. Although the devices may be useful in detecting recently committed crimes, or ones in progress, their effectiveness is limited unless the police respond quickly to calls for help. Furthermore, the effectiveness of any single technological device can be greatly enhanced by using it in combination with a number of other communication and surveillance systems. To varying degrees and for different time periods, electronic devices have been shown to successfully reduce police response time, criminal activity, and to improve the transit user's perception of security. Nonetheless, there are some major problems associated with these surveillance and communications systems. These include vandalism of the equipment, monitor fatigue, frequent false alarms, and expense.

Closed circuit television is being used in many transit stations to monitor critical access points and platform areas. However, dependent upon the extent of the system, the manpower required to monitor the closed circuit cameras can represent a major expense, and monitor fatigue can limit the effectiveness of the technique. Nonetheless, closed circuit televisions represent a key technique in several existing and proposed security systems. They can be used with other devices in a variety of security system configurations. For example, the cameras can be used in response to activated alarms to confirm the validity and nature of the calls. Similarly, cameras at access points can be activated by alarms within the station to videotape all people entering and exiting the station. The Teleview Alert system, used by the Chicago Transit Authority, may represent one of the most integrated systems of closed circuit television cameras and communication devices.

Communication devices can include non-voice alarms, emergency telephones, one-way voice alarms, two-way radios, public address systems, and voice monitors. Two-way communication systems permit station attendants or police personnel to respond to passenger inquiries or calls for assistance. As mentioned, a combination of communication techniques may be the most effective security measure. For example, one-way communication with the platform areas could be achieved by using a public address system. For communication between trains and a central monitor, two-way radios could be used, or alarms could be used in conjunction with automatic vehicle monitoring which would identify the location of the vehicle from which an alarm was issued. Alarms could also be used in the station area, setting off an audible signal in the immediate area, or linking to a central monitoring system from which police personnel or transit security forces could be deployed. Detection alarms reacting to human movement, heat, or vibration could also be employed to monitor areas which should not be disturbed.

Support Activities

Support activities represent an attempt to influence the incidence of transit crime or passenger perceptions through agencies or institutions external to the transit system, or to modify the behaviour of transit patrons or personnel. Liaison activities with schools and courts is an example of the former; training for operators in human

relations, an example of the latter. In addition, there are a variety of community relations, job training, local monitoring, and local improvement programs. These activities are typically initiated by the transit authority in conjunction with other groups or individuals and they impact upon the cognitive image of transit systems. A favorable image is very important for a transit system in order to maintain high levels of ridership.

Selective Operating Procedures

Operating procedures of the transit system may be varied in order to avoid risk of crime. These actions can include skipping stops, eliminating certain transit runs, and minimizing waiting time for passengers by reducing headways between trains. The latter step is desirable because transit passengers assume the highest risk of victimization while waiting on platforms for trains.

In AGT systems, such operating procedures could be used extensively, particularly in more sophisticated systems which have branching capabilities and off-line stations. These permit origin-to-destination routing, thus eliminating unnecessary intermediate stops. Because of the lower capacity of AGT transit vehicles, headways could be much shorter than on conventional transit. In some cases, service could be provided upon demand, reducing waiting time to a minimum.

Matching Countermeasures and Crime Conditions

To be effective, the selection of countermeasures must be consistent with expected crime conditions in a given location. Thus, it is necessary to predict the type and magnitude of crime, given a location, and then to identify the potentially tractable characteristics of these crimes. Table 10 illustrates how this might be done with the crime of passenger robbery.

The entries in Table 10 are purely illustrative and do not represent a complete or even a consistent analysis. Such an analysis should be conducted more thoroughly, on a site-specific basis, though a number of analytic problems and choices (Chapters 7 and 8) must first be dealt with. The general strategy reflected in Table 10 is to first sort out those transit crime characteristics which appear tractable (potential for amelioration via crime countermeasures) from those which do not. Then specific countermeasures are preliminarily matched against the tractable crime characteristics which they might affect. For example, increased police patrols at night on trains could potentially help reduce early morning and weekend robberies on low-volume trains.

Table 10
LINKAGES OF TRANSIT CRIME CHARACTERISTICS WITH STATION COUNTERMEASURE

Crime: Robbery (Passenger) — Characteristics: Apparently Intractable	Characteristics: Potentially Tractable	Station Countermeasure[1]
-- Victims often observed with large supply of money	-- Occurs in poorly lit, poorly surveillanced areas, e.g., stairwells, restrooms, parking lots, etc. (a)	-- Improved lighting (a)
-- More prevalent at night	-- Trains with few passengers are prime targets for on-train robberies (b)	-- Improved surveillance of concealed areas (a)
-- Most victims are lone white males	-- Apprehension increased with rapid response, particularly while crime in progress (c)	-- Security patrols (b)
-- Tend to be associated with incidence of batteries	-- Police evaluate their performance by robbery clearance rates; more attention devoted to high rate areas	-- Alarms (a, b, c)
-- Offenders in groups of two or three	-- Most occur from 6:00 P.M. to midnight; usually Friday and Saturday (b)	-- Eliminate concealed areas/secure these areas (a)
-- Almost no witnesses for on-train/station robberies	-- Few during morning and early afternoon	-- Exact fare system to reduce rider exposure of cash
-- Tend to be distributed evenly between armed/strong-armed	-- Most serious crime because of its frequency/endangerment	-- Increased patrols at night/on trains (b)
-- Few attempts reported, indicating that most robberies are successful	-- Most offenders leave station as soon after offense as possible; escape via stairs/ramps as opposed to station lobbies or trains (c, f)	-- Density controls (a)
-- Most often reported when injury sustained, property stolen		-- Victim reporting systems (d)
-- Majority of offenders under age of 31; half are under 21		-- Rapid security response (c)
-- Most offenders live in depressed areas. Most commit offenses within same police districts in which they live		-- Improve accuracy of identifying crimes in progress (c)

[1] Apply to potentially tractable characteristics only; letter designations indicate linkages.

Table 10
LINKAGES OF TRANSIT CRIME CHARACTERISTICS WITH STATION COUNTERMEASURE (Continued)

Crime: Robbery (Passenger)	Characteristics: Apparently Intractable	Characteristics: Potentially Tractable	Station Countermeasure[1]
	-- Guns most frequent weapon used, knives second most frequent; almost always displayed when exist. Most victims white males, followed by white females.	-- Most victims do not report crime until they arrive at their stops (d)	
	-- Victims often approached from front when robbed by one offender; front-rear with two offenders; from any direction with three offenders		
	-- Most injured victims require hospitalization		
	-- Money is the item most often taken		
	-- Generally losses under $20		
	-- Tend to occur in late autumn and winter; most occur on weekends		
	-- Few occur in morning and late afternoon, occur most between 6:00 P.M. and midnight		
	-- Victims have few options for escape or defense		
	-- Unsuccessful robbery attempts may most often not be reported		

[1]Apply to potentially tractable characteristics only; letter designations indicate linkages.

Table 10
LINKAGES OF TRANSIT CRIME CHARACTERISTICS WITH STATION COUNTERMEASURE (Continued)

Crime: Pickpocketing	Characteristics		
	Apparently Intractable	Potentially Tractable	Station Countermeasure[1]
	-- Low-priority crime, often unreported	-- Low clearance but fosters patron attitude of lack of security	-- Density control (a)
	-- Sleeping riders prime targets	-- Occurs in restricted doorways, crowded loading platforms; when riders are in close proximity to each other such as when entering/leaving system; occurs most in high pedestrian traffic (a)	-- Improved surveillance (a)
	-- Offenders work in groups of two or three	-- Require rapid exit (f)	-- Public education (e)
	-- Offenders seek anonymity		-- Train seat arrangement such that seats do not face each other
			-- Secure all unnecessary entrances/exits (f)

[1] Apply to potentially tractable characteristics only; letter designations indicate linkages.

As Table 10 suggests, some crime characteristics imply countermeasures which, in turn, should be evaluated in light of previous experiences with the technique (if applicable). Consideration should be given to the anticipated effectiveness of the countermeasure in terms of crime reduction and improved user perceptions, cost, flexibility, and acceptability. (See Chapters 7, 8, and 9.) Based upon these criteria, a security package could be devised.

Countermeasure Hierarchy

Figure 1 summarizes a ranking of countermeasure types according to their degree of flexibility, reflecting in turn their tie to structural or operational features of a transit system.

Of the five forms of countermeasures, design features and target hardening are most basic. In the construction of any transit station, regardless of location, a fundamental level of security precautions should be incorporated into the design. These correspond to such elements as good lighting, open site design, controlled access, automatic fare collection systems, and gates which inhibit fare evasion.

GENERALIZED RANKING OF COUNTERMEASURES
Figure 1

In addition to these basic design principles, electronic or mechanical communication and surveillance devices can be installed as a secondary level of security precaution. In virtually all cases, some form of communication is desirable. The actual form of the system can be determined based upon the anticipated crime characteristics of a neighborhood and the projected effectiveness of the various techniques. Although the installation of communication/surveillance devices permits a degree of flexibility, they do represent a substantial investment, and after installed, are relatively inflexible.

A tertiary level of security measures is provided by police operations. Deployment strategies are extremely flexible and can be adapted to the crime problems at a given location. To a certain extent, police operations are structured by the design features of the transit system, the primary level of security precaution, and are also interfaced with communications/surveillance techniques.

The other forms of countermeasures, including support activities and selective operating procedures, may be instituted in conjunction with the more fundamental techniques. The feasibility of instituting selective operating procedures is, in part, dependent upon the design of the transit system. For example, certain forms of AGT systems which have off-line stations and branching capability permit origin to destination service and eliminate unnecessary stops. Support activities, on the other hand, are not dependent upon the system design. Rather they are initiated by community groups and, in some cases, the police department.

In general, the flexibility of countermeasures increases as suggested in Figure 1. The basic lower levels of the pyramid, including design features, target hardening techniques, and electronic countermeasures, can be adapted to the physical, social, and crime characteristics of a given location. In these terms, countermeasures may be classified either as structural or operational.

Difficulties Caused by Human Factors

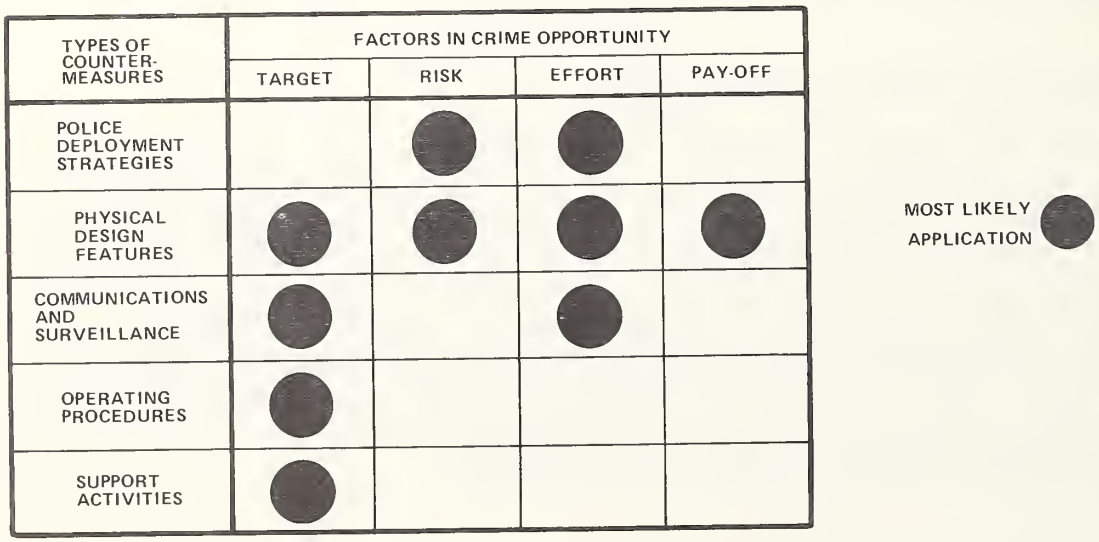
In a similar manner, crime characteristics may be divided into two categories—those within control of the transit system, and those which are not. Even if a full complex of countermeasures were instituted to address those crime characteristics within the control of transit systems, crime would not be eradicated because human factors would remain. For example, if robbery victims were seen flashing an ample supply of cash before they were robbed, improving the lighting, increasing surveillance, or implementing exact fare systems, would not eliminate the victimization of this type of person. No matter how extensive the implemented security measures are, total security can never be guaranteed. Offenders can be just as innovative in crime as others are in developing countermeasures.

Many human-related crime characteristics are outside the control of a transit system. There is little that a transit system can do, for example, to keep patrons from sleeping on trains so as to avoid becoming victims of pickpockets, or to prevent women from carrying purses so as to avoid falling victim to purse snatchers.

Innovative alternatives or supplements to traditional countermeasures should be investigated. One possible approach (Chapter 6) is to mobilize neighborhood resources in an effort to combat crime, i.e., emphasizing approaches which minimize perceptual and actual barriers between transit stations and neighborhoods, and foster a vested interest on behalf of local residents in the stations. One approach might be, for example, to award vending franchises to local residents. Granted, this would produce other crime opportunities, but it would also serve a surveillance function, which otherwise would not be available on a systematic basis in a fully automated station. Furthermore, such action might instill in residents a feeling of territoriality for the station.

Countermeasure Summary

For purposes of analysis, a matrix may be constructed matching the five types of countermeasures and the four basic crime characteristics cited in the previous chapter (see Figure 2). Thus, along one axis of the matrix are the factors associated with opportunity for crime: target, risk, effort, and payoff. Along the vertical axis, the five countermeasure techniques are listed: design features, communications/ surveillance devices, police operations, selective operating procedures, and support activities. Using this matrix, judgmental comparison suggests those crime factors upon which countermeasures might operate most significantly. Not unexpectedly, design features have the broadest influence on all crime factors. Each successive level of countermeasure focuses on a more specific aspect of crime.



POTENTIAL APPLICATION OF COUNTERMEASURES
Figure 2

In a similar manner, the effectiveness of different countermeasures varies with respect to different crimes (i.e., robbery, fare evasion, etc.). In order to predict the most effective countermeasures in a given setting, it is critical to: (1) predict the crime expected in that neighborhood, (2) rate the severity of the crime; (3) evaluate the effectiveness, both perceptual and actual, of the countermeasures with respect to the different crimes, (4) interface the predicted crimes (weighted by their severity) with the countermeasure effectiveness ratings and superimposed budget constraints, and (5) identify the countermeasures which will be most effective in light of a given crime environment. Thus, after a specific site and its surrounding neighborhood are defined, the initial step in determining effective countermeasures is to predict the anticipated type and intensity of crime. Methods for this task are addressed in Chapter 7, while techniques for countermeasures assessment are reviewed in Chapter 8.

Chapter 6
NEIGHBORHOOD RESOURCES AND CRIME REDUCTION

Traditional countermeasures typically recommended, developed, and/or implemented in transit systems tend to emphasize patrolling techniques, target hardening methods, or technological devices, including closed circuit television, alarm systems, improved station design, improved lighting, etc. The general objective is to increase the rate of apprehension of offenders, increase the safety and security of riders by reducing the likelihood of victimization, and to deter criminal activity by improving the opportunity for witnesses to become actively involved in reporting and/or assisting crime victims—all in an attempt to reduce the occurrence and fear of crime, with an ultimate goal of increasing ridership.

Traditional countermeasures seldom attempt to consider the relationship between crime in transit stations and the environmental location of the stations, even in light of evidence that crime in transit stations is often characterized by factors which relate to conditions outside the stations.

For example, robbery victims are often seen prior to their attack with ample sums of cash, and juvenile offenders are often most active during the post-school hours of 2:00 to 4:00 P.M. (29). The destruction caused by vandals and graffiti artists is often a form of retaliation to some perceived wrong (74), and the elderly are frequently victims of purse snatching (28).

Increasing security patrols, improving lighting, installing closed circuit television or alarm systems, etc., should often be augmented by media campaigns to educate the public about flashing sums of cash, suggesting that schools stagger their dismissal hours to control the number of juveniles in transit stations, or providing a specific location (and even materials) for graffiti artists to ''paint out'' their frustrations. Portland, Oregon, after emphasizing that riders not carry cash, found that the elderly carried cash because banking systems were too complicated. The banks were urged to simplify their banking procedures for the elderly, and the incidence of purse snatching from among this group was reduced (28).

Supplementing Conventional Countermeasures

It is important to emphasize that traditional countermeasures do have a place in the transit environment—but they must be supplemented to respond fully to those transit security and crime concerns which do not lend themselves to a mechanistic approach. This need is apparent in light of the fact that offenders are often just as creative in outwitting traditional countermeasures as others have been in developing them. Furthermore, crime continues to rise despite implementation of technological countermeasures. Offenders have simply worn a mask when committing crimes in places where closed circuit television systems are used; in some instances, they have even posed barefaced, in open defiance of the camera, alarm devices have been disarmed, and decoy teams have been outguessed.

Brill (6) noted that the limitations of hardware ". . . do not mean, of course, that no hardware should be used. The point here is simply that hardware should not be the primary focus. The search should be for that right combination of moves that together produce the desired effect—the synergism that strengthens the social fabric of the residents as well as hardens the physical plant."

In any given community, there are a variety of social service agencies, businesses, and groups which have specific responsibilities. State employment services find jobs, welfare systems provide income, the media provide public information, and community groups provide counseling and other assistance services. Each of these resources, when appropriately tapped by a transit system, could contribute to the reduction of transit crime and increasing security.

Developing additional appropriate countermeasures through the use of outside-the-transit-system resources could be a mammoth and complex undertaking. In general, the transit system has a clear responsibility for the safety and security of its riders and, therefore, must be aggressive in developing the most appropriate and effective crime reduction countermeasures. Consequently, transit operators, including potential AGT operators have a key leadership role in mobilizing both conventional and neighborhood resources.

Mobilizing Neighborhood Resources

Transit riders have an obviously major stake in transit safety and security. The rider not only depends on the transit system for transportation (particularly transit-dependent riders, who have no other transportation resources), but expects safe passage as well. The personal cost and impact of criminal attack can range from fear, trauma, and rage, to instances of loss of life, limb, or property. The cost of crime can also be measured in dollars and cents by the transit system's loss of revenue and property. As a result, the development of effective crime countermeasures is important to the transit system, its riders, and the residents of the communities which surround transit stations. These communities are the areas from which patrons are drawn, and they too, experience the crime which occurs in the transit environment.

Many inner city communities are plagued by a myriad of overlapping and interrelated social issues and problems which impact dramatically on the lives of their residents. Such areas are generally characterized by delinquency and crime, unemployment and underemployment, physical deterioration, low median incomes, inadequate recreational and mental health resources, and the like. Overwhelmed by the number and immediacy of these problems and the detrimental effect they can have on their lives, it is not surprising that community residents express a sense of frustration, apathy, and powerlessness. The problems are tremendously complex and often well embedded in the social structure, generally requiring a comprehensive and technical expertise to effectively respond to them.

Because neighborhood conditions are personal and immediate for residents, it becomes imperative for them to develop some kind of coping mechanism, even if only reactive patchwork, if they are to survive each day. Residents baby sit for working parents, establish car pools among groups of coworkers, form tenant associations, and prevent vandalism and burglary through neighborhood property-watching activities. These are generally recognized and naturally occurring neighborhood functions, which provide residents with important insights into the parameters of problems and issues, their potential and actual impact, and what works best to resolve them. The neighborhood response to problems is a resource which is often overlooked by institutions and intermediate organizations when issues are assessed, needs analyzed, and programs implemented. Such programs tend to operate from the perspective that residents lack the sophistication and skill themselves to address neighborhood concerns.

Community residents are, however, a principal and essential resource for efforts to reduce neighborhood crime. The effectiveness of community efforts can be further enhanced if residents are given assistance which augments their endeavors, instead of having these functions performed for them, a perspective often adopted by institutional organizations.

Increasingly, it is being recognized that the social ills of concern to inner city neighborhoods require the major input of residents. Misner (51) stated:

> ''It is ironic, however, that there has been little discussion of 'community involvement' in crime prevention. How else can effective crime prevention programs be developed *without* community involvement. . .
>
> ''Certainly, the concept of community involvement, in crime prevention or any other vital area of social concern, is not a new concept. It is part of the very fabric of self-government, of democratic government.''

The National Advisory Committee on Criminal Justice Standards and Goals (55:4) seems to concur:

> ''Although little systematic research has been done in this area, the reported incidences of communities getting 'together' suggest that active 'community involvement' in fighting the problems may well be an effective way, to prevent and reduce crime and delinquency.''

Washnis (88) also wrote on this subject:

> ''We are now beginning to see that it is too much to expect the police department to do the job alone. There must be involvement in the courts, and in the correctional system. There must be efforts at eliminating the underlying causes of crime, such as unemployment, poverty, racial discrimination, rootlessness, alienation. Above all, members of the community must play larger roles in crime prevention.''

Examples of Neighborhood Mobilization

The literature is replete with examples of neighborhood resident attempts to counter the social problems of concern to them and their communities.

In 1973, the concept of ''turf reclamation'' was implemented in Pittsburgh to organize public housing residents in nine developments around security issues. Turf reclamation, a term coined by R.J. Rosenthal at Temple University, suggests that ''people must regain control over their own neighborhoods, and that true security is a function of this control.'' (63). The project trains community organizations to assist residents in developing security in their neighborhoods.

An Oak Ridge (Tennessee) school curbed vandalism and provided needed recreational facilities by opening the building during off-hours for community use. The effort developed community pride in the school and also curbed vandalism since community residents in essence were serving as late evening and weekend guards (56).

Using an indirect approach to crime and delinquency prevention, HUD has sponsored public housing tenant management projects in selected cities (Jersey City, Louisville, New Orleans, Oklahoma City, Rochester, New York, and New Haven, Connecticut). The strategy is to help tenants manage their own buildings in an effort to reverse physical and financial deterioration. Charles Orlebeke, HUD's Assistant Secretary for Policy Development and Research, says, ''The basic concept is, when people have a stake and some measure of control over their living environment, they will have a more positive attitude.'' (40).

An example of a community-based, comprehensive approach is the Union Avenue Redevelopment program operating in Portland, Oregon.This is an effort involving residents, city officials, and the federal government in the revitalization of the area, increasing its economic vitality and, thereby, reducing crime and the fear of crime. The economic vitality of an area was considered to be directly related to crime and the crime rate. ''Abandoned, boarded-up stores provide hideouts for offenders. Unattractive commercial areas decrease the likelihood that new business will move in. They also ward away potential customers. As businesses close, there are fewer 'eyes on the street' that would give customers and nearby residents a sense of security. As unemployment rises, so does the number of street corner loiterers. Fear of crime increases accordingly.'' (49).

A number of projects were implemented under the Portland plan. The safe streets for people project sought to improve the physical environment, and called on residents to implement block watching programs and a program setting up certain homes as safe havens. Residents frequenting the area were involved in neighborhood clean-ups and Sunday markets. A public awareness campaign discouraged people from carrying cash on the streets and established a number of alternatives, such as making travelers' checks available at low rates, and having banks offer bill-paying services.

Neighborhood Territorialism

A recurring theme appearing throughout this discussion of neighborhood countermeasures, implemented at the direction of or with the major assistance of community residents, encompasses the notion of territorialism. Among neighborhood residents, territorialism involves installing and/or capitalizing on the attitude among residents that they have a personal stake in the condition of their neighborhoods. The concept also suggests that the overall reduction of urban social problems requires the concerted and well-defined input in all community components with a concern for the well-being of the area.

The notion of territorialism and its objective of community involvement can be a difficult concept to initiate, manage, and/or coordinate. For too long, residents have been led to believe that there is little they can do to effect social change; that those functions are to be performed for them by those better qualified. Complaints about the quality of services received are often met with red tape and bureaucracy, which in turn creates alienation, distrust, and the feeling of powerlessness. This is particularly true for the low-income resident. Brill (6), in discussing the issue of security in public housing states:

> ''Social relations in such a project are marked by distrust. Few people dare to rely on one another. The social posture of the residents is basically defensive and insular. There is a good chance that many residents feel alienated from the larger society as well as from each other. This same feeling often extends to the housing authority, the local public agency that is responsible for managing the project. In many cases, housing authorities have not been able to involve tenants sufficiently in the management process, and discontent is likely to exist among residents over this issue, as well as over the general quality of management services being delivered by the authority. Residents frequently feel, and with good reason, that housing services (for example, maintenance) are inadequate; and they see these deficiencies as one more sign of their social isolation and neglect. Vandalism, in some instances, is an expression of just that feeling; a destructive act against an environment found barren and oppressive, one which residents have no stake in and would like to destroy.''

Closure, another concept used to describe the activities and procedures of a neighborhood which operates to protect itself, tends to exist in neighborhoods of "mutual" identification, interactional intensity, and *esprit de corps*" (34). Thus, neighborhoods where closure or territorialism attitudes are weakest are those with the most alienation and the least self-policing behavior among residents. This creates the ideal location for crime and delinquency to occur.

> "Indeed, with each citizen looking out for himself only, there is no community, no strength in numbers, but rather a fragmentation that can serve only to embolden criminal elements." (55).

Reversing years of such indoctrination is difficult—but the effort is often well worth it. Washnis (88) adds:

> "In regard to developing a sense of community, block associations have been one of the most effective ways of bringing people together. In city after city the majority of block members report that they had not known most of their neighbors and that only through block club coffee sessions and regular meetings and the door-to-door contact had they really gotten to know each other and to appreciate mutual problems. In many cases, prior to block organizing, even neighbors next door to each other communicated infrequently. Crime prevention provided the motivation to get together, and block associations offered the mechanism for doing it. The simple factor of adults and youth knowing each other has helped to reduce fear. Familiarity has developed friendly attitudes and increased concern for one's neighborhood."

Adding further, Washnis noted (88) that often crime reduction has been attributed to:

> "Increased citizen altertness and reporting of crimes, more responsive police in areas where block clubs function, better home and property security, and the presence of community activities—such as neighborhood walks and patrols, meetings and workshops, use of warning devices and other techniques—which tend to discourage the criminal element or cause them to operate elsewhere."

Neighborhood "Social Control" in the Transit Environment

Many of the crime prevention activities described in the previous section address residents' interest in protecting something or some group in which the resident has a stake, a commitment, or a sense of responsibility. If residents are made to feel that they have a genuine stake in the reduction of crime in their neighborhoods, and that their input is necessary to insure a safe environment, they are more likely to commit themselves to its protection. Thus, under the broad heading of "social control" falls a series of neighborhood-related countermeasures, regularly attempted in urban neighborhoods. These, we believe, could have application to the transit environment.

Development of Neighborhood Commitment

How, for example, do territoriality or other sources of informal social control develop in a neighborhood, and how might they be developed in the transit environment. These are difficult questions which clearly indicate that more work is necessary in the assessment of social control, and its application to transit. We have been able to find but a few studies that bear directly on this social control issue. Repetto (62) skirted it, but with fragmentary, indirect data. Boggs (3) analyzed differences in attitudes relating to social control of crime at a macro-level among urban,suburban, and rural settings. Maccoby (46) demonstrated the importance of informal social control in relation to delinquency, but without reference to physical setting.

However, on the specific issue of the relationship between local physical setting and informal control, the literature offers no guidance. Because conventional literature provides little direction, we found it necessary to turn to other bodies of research for analogs and models to attempt to describe the possible application of informal social control to the transit environment. The literature on ''Good Samaritan'' behavior seems a logical choice.

The behavior that leads people to call the police when they see a transit robbery being committed, or to warn a neighbor if they see a teenager prying into a neighbor's mailbox, are surely related to the impulses that lead people to help one another in their neighborhoods. Even more importantly, it is plausible that the direct outcome of increased social control in a transit environment, will not so directly impact crime prevention, or related behavior, as it will involve an increase in ''helping'' propensities that, in turn, will set the stage for modifying eventual crime-related outcomes. It seems relevant to consider the circumstances under which people help others, and its possible application to the transit environment. Under what conditions, for instance, can users of the transit system be influenced to help each other, and to what extent?

''Helping'' Among Neighborhood Residents

This topic is relatively new, dating from the studies of Latane and Darley in the late 1960s. Nonetheless, it has now accumulated a significant body of literature. The kinds of helping that have been scrutinized include donations of time or money, rescue behavior, reporting to authorities, and general ''volunteerism.'' Situations have included simulated emergencies and casual requests. The only essential defining element of ''helping'' in the research has been that the subject extends personal effort and incurs personal costs, whether in money, time, labor, pain or physical danger.

A finding of immediate interest is that the presence of an audience may or may not encourage helping. It appears that the crucial determinant is whether people viewing an activity perceive themselves as a circle of neighbors and friends or as a band of strangers. Latane and Darley (41) and Latane and Rodin (42) were the first to demonstrate that subjects are slower to respond and, in general, are less

likely to help when others are present, even when the stimulus is dramatic (e.g., observing a simulated "epileptic seizure"), or a direct request (e.g., hearing a woman in the next room fall and call for help).

These studies were subsequently supported by work by Clark and Ward (13), and in a study of library theft by Shaffer, Rogel, and Hendrick (13). The dynamics at work were said by Latane and Darley not only to be reticence, but "diffusion of responsibility," which lowered an individual's felt sense of responsibility. An attitude measure used by Wolosin, Sherman, and Mynatt (93) later provided supporting evidence for Latane and Darley's inferences about these dynamics.

As might be expected, these studies and others provide evidence that the inhibiting effect of the presence of others is diminished or even reversed when the bystanders are friends of the subject (42, 13). The inhibiting effect also tends to disappear when the setting is a tightly-knit community. The presence of others actually increased the willingness of people to respond in a study of altruism and intervention in a rural Georgia community (2).

From the perspective of the transit operator, the most important of these studies were conducted in Edmonton (Alberta Province, Canada) by Hackler, Ho, and Urquhart-Ross (25), who scored 12 areas of the city on sociometric variables, such as degree of interaction, and then compared these areas by the residents' willingness to intervene in helping situations. They found a group facilitation effect in high interaction communities, contrasting with no such effect in low interaction communities. Similarly, they found that helping behaviors are more prevalent in stable than in unstable neighborhoods.

There are several other factors found to influence helping behaviors. For one, community size is important. Consistently, helping behaviors occur more readily in rural communities than urban ones (63, 20, 13, 37). Density discourages helping (43, 29, 48, 1). Noise is negatively related with helping (47).

Taken together, all of these findings suggest that helping is least likely in urban, dense, noisy, unstable neighborhoods. If AGT systems are to be operated, in part, in an environment similar to these, then it seems entirely appropriate to make a careful assessment of how social control operates in the neighborhood, and how these experiences might lead to applications in the transit environment.

Neighborhood Countermeasures and Transit Crime

A number of different approaches to and types of neighborhood crime reduction countermeasures have been discussed in preceding sections: mobilization of neighborhood organizations, tenant associations, business groups, church groups, and others to better "protect" neighborhood resources; encouragement/stimulation of neighborhood "territorialism," or the feeling of pride and

"ownership" in the neighborhood; the concept of informal "social control," emerging from greater commitment to "helping" among neighborhood residents, which in turn can be associated with neighborhood mobilization. Each of these strategies involves different dimensions of increased *citizen involvement* in crime reduction, at a *neighborhood* scale. Treating transit stations (conventional rail, AGT, even bus stops) as an *integral part* of the neighborhood which must be better protected is the key to better relating these strategies to the transit environment.

The ultimate objective of analysis, in examining neighborhood countermeasures for their transferability to the transit environment, is to identify particularly successful neighborhood countermeasures that impact that part of the neighborhood environment which is similar to the transit environment. The determinants of effectiveness and transferability are related to informal social controls, particularly those which can be manipulated positively in the transit environment.

When we combine these determinants with the major concepts that underlie current approaches to transit crime prevention, we find that the major questions which arise can be clustered around three central constructs. These are: (1) the built environment affects the pattern of personal day-in, day-out transactions, (2) personal responses to an issue are in part shaped by "investment" in that issue, and (3) the action people take (or fail to take) at a critical moment is, in the main, a rational one which reflects net trade-offs, as they are perceived.

Citizen Response to the Physical Environment

The first of these constructs follows from the assumption that the built environment affects the pattern of behavior in all important transactions, including transactions related to crime. It is reasonable to hypothesize that the built environment influences citizen response to crime by determining how the neighborhood works and how the transit system works. Underlying the literature of the major environmental designers is a fairly vague image of how communities work. Few have articulated this image well, but as we examine the kinds of social control they try to energize, the image that comes across is that of small-town America (or the prevailing stereotype of it).

The social controls postulated or implied envision a community where people look over each other's shoulders, in which everybody-knows-everybody, in which neighbors really act like neighbors in the good, old-fashioned sense of the term. Many of the environmental changes that are frequently proposed (and actually made) seem to depend on this type of ideal community, as a stimuli for the desired citizen response.

Yet, this image of a community clearly does not fit the neighborhoods in which the rates of crime are highest, and in which many of the new automated guideway transit systems would have to operate. Nor, does it seem at all possible that these neighborhoods (and, indeed, most neighborhoods) will ever function like this, no matter how the built environment is altered. No manner of redesign and design of neighborhood or transit environments will alone alter the behavior of experienced offenders unless the physical environment is supported by a full range of other social control activities.

The first key issue linking environmental change to crime then, is the nature of the community in which the crime is occurring, and the community's impact on the transit system which operates in the area. Once understanding the true nature of individual communities, the transit operator and the criminal justice community will have an opportunity to mediate rider and resident response with regard to informal social controls.

Citizen Response and Neighborhood Values

The second important construct, the vested interest issue, derives from the inarguable reality that personal responses are shaped by personal investment in the matter at hand. The norms of the community lead to different expectations for personal responses concerning one's own home, children, and property, and for responses to matters affecting friends, neighbors, or strangers. Different kinds of property, different types of risks, different forms of trespass, also are associated with different local values. And individual differences in values, within the broad context of the overall norm, also are large and produce further variations.

Current practices to increase personal concern and interest in transit environments rely on a more responsive representation of "neighborhood" investments and values. Many of the new transit systems attempt to ostensibly design stations to fit the "prevailing" culture and attitudes of local residents. These new stations make extensive use of basic environmental design concepts such as open sight lines, landscaping techniques to establish symbolic barriers, and other elements which in some way increase the rider's sense of territory and ownership worthy of protection.

The difficulty is that no one really knows whether symbolic changes have any effect independent of accompanying differences among neighborhoods, neighborhood residents, and crime participants regarding locally held values. Yin is currently working on this question from the point of view of impact on the offender (94). What is needed is information on the impact on rider behavior and the extent to which the rider views the transit system as his or hers to be protected. This should, of course, be part of a larger exploration of the dynamics of the rider's degree of investment in the transit system, and ways by which the rider and the local community can feel an increased sense of control and ownership of that transit environment.

Citizen Response to Crime Activity

The third construct is assumption that actions people take (or fail to take) are usually rational ones which reflect the net of positive and negative impact trade-offs, as they are perceived. Community norms strongly affect the assessment of these trade-offs. The degree of individual investment determines the weight attached to the possible outcomes of alternative courses of behavior. A crucial factor also lies in the individual's assessment of the probabilities associated with each of these outcomes, and the rewards/costs each represent.

The action taken at the moment when an offense seems imminent or is occurring, or has just occurred, surely depends on whether the individual is with friends or alone, whether or not there are serious probabilities of recognition and reprisals, etc. Countermeasures must be introduced in the transit environment which affect the many factors that determine these probabilities, or people's judgment of them. We do believe that, if in the right combination, both conventional and social control countermeasures may be able to influence the individual's sense of control, in assessing the situation as one that he can or cannot manage.

Part III
PREDICTING STATION SECURITY REQUIREMENTS

Chapter 7
CRIME PREDICTION TECHNIQUES

Efforts to relate population characteristics to crime rates in urban areas have been made for decades. The majority of these studies have focused on characteristics of known offenders or general population characteristics within a city. Many attempts have been made to predict crime rates in large urban areas, but these techniques have seldom been applied to smaller urban areas. Two techniques which are frequently used in these efforts are regression analysis and factor analysis.

Multiple Regression Analysis

Multiple regression analysis is a statistical technique which associates two or more independent variables with one dependent variable. The technique may be used to investigate the causal relationship between the independent and dependent variables; alternatively, it may be used to generate (or forecast) unknown values based upon a variety of known and available data. Although these two functions of regression analysis seem closely correlated, they are not necessary conditions for one another. Further, statistical relationships only *imply* causality, they do not "prove" it.

Nonetheless, in this study, it would be most desirable to present a "causal" model which could be applied to known characteristics of a given neighborhood in order to predict crime in the area. Previous studies have found, as discussed earlier, that the type and frequency of transit crime is similar to crime characteristics in the surrounding neighborhood. In turn, street crime has been correlated with social characteristics of neighborhoods; so, by a logical progression, transit crime should also be associated with demographic characteristics of neighborhoods. To test this hypothesis, regression analysis can be and has been employed.

BART Crime Forecasting Model

The most recent study which tests the association between socioeconomic neighborhood characteristics and the type and number of transit crimes is being

conducted at the University of Virginia (31). Regression analysis has been applied to a sample of stations in San Francisco's BART system to generate models which could forecast crime based upon neighborhood characteristics. Four separate models were developed, corresponding to the following crime types: (1) crimes against persons, (2) crimes against personally-carried property, (3) crimes against station/transit property, and (4) crimes against the public. More specific crimes included under each type are listed in Table 11.

The observation used in the regression analysis involved neighborhoods surrounding 32 BART stations. Each neighborhood was defined as the area within a one-third mile radius of the station. Socioeconomic data, the independent variables, were extracted from the 1970 census for the tracts or portions of tracts falling within the circumscribed neighborhood area. The dependent variables were aggregated from 1977 crime statistics obtained from the Bay Area Rapid Transit Authority's records. The use of both 1970 census data and 1977 crime statistics assumed that neighborhood characteristics had not changed over the seven year period.

The independent variables, the socioeconomic characteristics of neighborhoods, included sex, age, race, employment, occupation, education, and income. Twenty independent variables initially were tested in each of the four models corresponding to the crime classifications. The resulting regression equations had coefficients of determination (R^2) ranging from .25 to .44 (see Table 12). This indicates that the independent variables explained between 25 and 44 percent of the variation in crime rates.

Significant Variables in the BART Model

The four models, each corresponding to a particular crime classification, differed; however, in most cases, the significant variables correspond to basic intuition. For example, the model for *crimes against persons* (assault, battery, homicide, manslaughter, etc.) had positive coefficients for these independent variables: percentages of neighborhood males age 20 to 54, percentage of blacks, and percentage of Spanish, and a negative coefficient for the percentage of professional employment in the neighborhood.

The model for *crimes against personally-carried property* (purse snatching, pick-pocketing, and robbery) included only two significant independent variables. These were the percentages of males between 20 and 54, and the percentage of families below the poverty line.

Crimes against station and transit property (i.e., vandalism) were found to be positively associated with the percentage of neighborhood males through the age of 14 and the percentage of females over the age of 20. Also, it was negatively correlated with the percentage of females through the age of 14. In general, vandalism and associated crimes were linked to younger populations.

Table 11
CRIME TYPES COVERED IN FORECASTING MODELS

(1) Crimes Against Persons

- -- Assault
- -- Battery
- -- Homicide/manslaughter

(2) Crimes Against Personally-Carried Property

- -- Purse snatching
- -- Pocket picking
- -- Robbery

(3) Crimes Against Station Property

- -- Structural burglary
- -- Fare evasion
- -- Vandalism
- -- Petty theft
- -- Trespassing
- -- Arson
- -- Rock throwing

(4) Crimes Against the Public

- -- Drug law violation
- -- Sex crimes (e.g., indecent exposure)
- -- Drunkenness
- -- Disorderly conduct
- -- Concealed weapons

Source: Reference 31.

Table 12
ILLUSTRATIVE TRANSIT CRIME FORECASTING MODELS

Crimes Against Persons

I. Number of Crimes = .12 (percent male 20-54) + .23 (percent black) + .04 (percent Spanish) - .055 (percent professional) - .189 (R = .6).

Crimes Against Personally-Carried Property

II. Number of Crimes = .13 (percent male 20-54) + .25 (percent poverty families) - 1.69 (R = .5).

Crimes Against Station/Transit Property

III. Number of Crimes = 17.88 (percent male through 14) + .72 (percent female over 20) - 16.20 (female through 14) + 9.68 (R = .6).

Crimes Against the Public

IV. Number of Crimes = 1.32 (percent male over 55) - .34 (percent professional) - .46 (percent female over 20) + 28.82 (R = .66).

Source: Reference 31.

In contrast, *crimes against the public* (including sex crimes, drunkenness, and disorderly conduct) were associated with older populations, particularly the percentage of males over 55 in the neighborhood. It was negatively correlated with the percentage of professional employment and the percentage of females over the age of 20.

Limitations of Regression Analysis

At least in its preliminary stages, the University of Virginia study does not examine the problem of multilinearity among the independent variables, or possible violations of other regression assumptions. Regression analysis is a fairly robust statistical technique. Nonetheless, it is based upon a number of assumptions which should be tested to determine the appropriateness and validity of its application.

One basic assumption of regression analysis is that the independent variables are uncorrelated; when this is not the case, multicolinearity exists. This, in itself, would not impair the overall predictive capability of the model. However, it does invalidate the interpretation of individual variable coefficients. Diagnostic checking of other regression assumptions should also be performed as such models are refined. Identification of significant violations (i.e., non-constant variance in the error terms, non-linear effect of independent variables) could necessitate respecification of the model and, possibly, the need for variable transformations.

The predictive capability of the Virginia models, in general, is quite limited. The independent variables failed to explain between 56 and 75 percent of the variation in annual crime rates. These are not models which could comfortably be used to predict total annual crime rates in other environments. In an effort to improve the explanatory capability of the models, land-use information (i.e., the percentage of residential, commercial, industrial uses in each defined neighborhood) could be appended to the socioeconomic variables. Land-use would be expected to have some bearing on the type and rate of crime in a given area.

In general, a regression model can be no better than the data upon which it is based. Thus, it is essential to determine the quality of transit crime data as well as demographic and land-use statistics. A number of problems and inadequacies are associated with crime statistics. For example, in some cases, a basic concern is the classification of a crime as transit-related. This becomes an issue when crime occurs in the immediate station vicinity. Beyond this, many crimes which occur in transit systems do not come to police attention and, even when they do, discretion is used by police in reporting the incident. There is also a lack of uniformity in the classification of crime types, the scale of crime seriousness, and the format for reporting details of incidents. When more than one security force exists (i.e., both a transit police and municipal police force), there is additional concern about the consistent recording of criminal reports and the completeness of transit police records.

A final consideration in using regression analysis to predict crime is to determine the most appropriate form for the dependent variable. The Virginia study used total annual crimes recorded by the transit authority. Given the identified data limitations, consideration might also be given to using a factor representing true crime rates (derived from victimization surveys or related techniques) as the dependent variable.

Crime Forecasting as a First Step

Besides using regression analysis to predict crime based upon socioeconomic characteristics, such a statistical technique could also be used to generate trend factors to adjust prior crime data into trend-line crime forecasts. Trend factors would be a function of changing socioeconomic and land-use characteristics in a neighborhood, instead of static conditions as in the Virginia study. However, such a dynamic analysis would encounter additional data problems associated with inconsistencies over time.

Predicting crime is merely a first step in identifying appropriate countermeasures for future guideway transit stations (both automated and non-automated). Once the type and intensity of crimes are predicted, these must be ranked according to their severity, both actual and perceptual.

This, in turn, must be interfaced with an evaluation of countermeasure effectiveness with respect to different crimes. Countermeasure effectiveness must be judged relative to a countermeasure's ability to determine: (1) the effectiveness of countermeasures themselves, both actual and perceptual, (2) the adaptability and flexibility of the technique (its ability to be interfaced with other countermeasures and adjusted with changing circumstances), (3) the capital and operating costs associated with that countermeasure, and (4) the acceptability of the technique from the perspective of transit users and transit personnel. In order to evaluate countermeasure effectiveness in terms of these criteria, a number of techniques may be employed, and these are reviewed in the following chapter.

Factor Analysis

Factor analysis is a technique used to determine patterns, regularity, or order within a given set of data. Its basic concern is with the interrelationships among a large number of variables. It does not necessarily define causal dependencies; however, it may be used as a step in clarifying such associations. In the book, *Applied Factor Analysis,* R.J. Rummel describes the various applications of this technique. It may be utilized to (1) determine patterns of interrelationships, (2) reduce large amounts of data, (3) clarify the structure of a relationship, (4) classify or describe data, (5) scale data, (6) test hypotheses, (7) transform data, or (8) examine theory. (66).

When using this technique, there are no data restrictions, (i.e., limitation to a particular numeric scale or to normally distributed samples), and any table of numbers may be evaluated. The methodology focuses upon related variation—those variables which change in a similar manner over time or space are linked together to form a factor.

Perhaps factor analysis is more easily understood when described in geometric terms using vectors and vector space. Given any data set containing a number of observations for which "n" variables have been recorded, one may picture an "n-dimensional" space with each observation represented as a single vector within this space. Similar observations will fall in the same general vicinity in the vector space. It is the purpose of factor analysis to delineate these groupings of vectors and reduce the initial vector space to one of fewer dimensions, defined either by common factors or by principle components. In essence, in the spatial context, factor analysis may be thought of as a method of determining the dimensions needed to describe variation among variables. Each of the reduced dimensions defines an independent source of data variability. (66).

By itself, the single term "factor analysis" encompasses several different approaches—the most familiar ones being common factor analysis and principle components analysis. The basic difference between the two is that in principle components analysis, all variation in a population of observations is assumed to be contained within the defined variables. In factor analysis, the variables are assumed to describe only a portion of the variation.

Factor analysis has been used to develop a crime and harassment index for crimes against both male and female transit passengers, based upon perceptions of transit security (92). Factor analysis can also be an effective technique in reducing socioeconomic and demographic information to a manageable number of composite factors. Conceptual labels may be devised, based upon the variable "loading," on the various factors. An example of factor analysis applied to socioeconomic data was contained in the Crime Prevention Through Environmental Design Study by Westinghouse Electric Corporation (35). In this case, 52 basic urban socioeconomic variables generated eight composite factors.

Reliability of Transit Crime Data

As mentioned earlier, problems with the reliability and validity of crime data are by now well known. Final official statements of crime statistics depend not only on actual criminal incidents, but also on such haphazard factors as victim awareness, victim and witness reporting to police, and police recording consistency. Lack of uniformity in defining and classifying crimes, including transit crimes, among jurisdictions has also created difficulties.

These problems are of as much concern in the study of transit crime as in other types of crime. In fact, the problems are even more acute in the study of transit crime, due to lack of clarity about boundaries and variable types of police organization and jurisdiction. The relationship of the transit system to its environment is not always clear. Although it is part of the total urban environment, it is sometimes viewed as a separate entity. The extent to which transit systems maintain their own security forces or divide responsibilities with local police illustrates this ambiguity. Since transit systems are sometimes treated as part of the larger area, and sometimes as a separate entity, and since responsibilities for the reporting of crime are sometimes divided, it is easy to understand how the accuracy of transit crime statistics can be suspect.

Confusion about crime statistics is evidenced in attempts which have been made to compare the relative magnitudes of street crime and transit crime. One estimate of the amount of crime on a transit system indicated that the chance of being robbed on that system was only one-third as much as being robbed elsewhere in the city. Using another method of computation, however, the transit system appeared approximately 20 times more dangerous than the rest of the city. A third approach, which relied on self-report data rather than official crime statistics, provided an intermediate figure much closer to the higher estimate (74).

Data on Countermeasure Effectiveness

Data problems of this magnitude suggest that definitive information on the relative effectiveness of proposed countermeasures will be difficult to obtain. For this and other reasons, including the recent nature of many countermeasures and the lack of rigorous evaluations, little was found in the literature regarding effectiveness.

One finding regarding the effectiveness of countermeasures did emerge quite clearly. Substantial increases in police patrols were found to reduce crime in general (11, 78). However, saturation also produced some displacement. In addition, saturation patrols are expensive and must be targeted and flexible. A study of the Alameda-Contra Costa (California) Transit District designed to reduce robberies and assaults of bus drivers concluded (81):

> ''. . . all police surveillance plans required a large investment to achieve any real effectiveness. Police surveillance plans can, therefore, probably only be considered practical for short periods of time in concentrated programs.''

Regarding technological devices, it is believed that closed circuit television, silent alarms, and two-way radio may have deterrent value and also may enhance police surveillance and apprehension capabilities. However, they have not yet been evaluated systematically. They also present problems in themselves as sources of false alarms and targets of vandalism (78). Only 40 percent of the bus drivers in Atlanta who had experience with two-way radios reported that they believed that the devices protected drivers from assault. Nevertheless, 88 percent recommended that two-way radios be installed on all buses. These anomalous findings suggest the purposes beyond security which technological devices can serve. The two-way radios, for example, were reported to help reduce the bus drivers' feeling of being alone (81).

Data on the transit crime control effectiveness of design features, known in its more expensive applications as Crime Prevention Through Environmental Design (CPTED), are also quite sparse. In the Alameda-Contra Costa Study, the use of exact fare boxes was shown to be quite effective, in the short run at least, in protecting bus drivers from robbery although not from assault. A discursive indication of effectiveness of design features focuses on the new Metro transit system in Washington, D.C. (90, 68).

With its great visibility, lack of hiding places, spacious atmosphere, and short passage to the surface, the Metro experienced only 46 reported crimes, all minor, in its first year of operations. This finding should be interpreted with caution, however. The Metro system also made use of police deployment strategies and technological devices, including closed circuit television, thus contaminating the analysis of the effectiveness of design features. In addition, the system operates from 6:00 A.M. to 8:00 P.M. only, and provides incomplete geographic coverage.

Difficulty of Cross City Comparisons

Since data on transit countermeasure effectiveness are limited, it follows that data comparing countermeasure effectiveness across transit modes are notable by their absence. Almost without exception, studies of transit crime examine mass transit systems on a city-by-city basis rather than by comparison of transit modes. This lack of comparison, and the related lack of microlevel analysis of the relationship of system characteristics to countermeasure effectiveness, greatly limits the utility of transit study findings for identifying implications for AGT systems.

Chapter 8
COUNTERMEASURE ASSESSMENT TECHNIQUES

In the remainder of the report, a number of survey and analysis methods will be assessed in terms of their applicability to the prediction of AGT station security requirements in urban neighborhoods. Conventional data collection approaches such as general population, attitude, and preference surveys, victimization surveys, and surveys of special groups, e.g., transit patrons and crime prevention experts will be included in the review and assessment.

Examples of rudimentary statistical analyses of transit crime and crime-related data will also be covered. Both time series (historical trend data) and cross section (data from only one point in time) analyses are included. The derivation of simple statistical indices is covered, as well as relational and causal studies of pertinent crime, transit, and/or neighborhood data.

Given the nature of the assignment, however, emphasis is placed on unconventional data collection approaches which may be more appropriate for application in a prediction effort attempting to relate neighborhood and transit station characteristics and experiences to one another. These unconventional data collection approaches include the key person community analysis process, the critical incident technique, behavioral observation, and environmental observation.

Background or Base Line Studies

Often an investigation of transit crime and existing or potential countermeasures will begin by assembling pertinent data which document present conditions. Various reports, records, data files, and similar information sources are consulted. This type of archival research involves examination of crime and demographic characteristics and related statistical information provided by the census bureau, police department, transit police, city planning departments, and other sources. Typically, these statistics are utilized in comparative studies, involving different subareas within an urban area, or comparisons with other cities.

Within a particular urban area, analyses of present transit crime patterns can, of course, have significant bearing on the crime potentials for proposed AGT systems.

These background or base line studies are generalized in nature and rarely deal with the specifics of countermeasure assessment. Even though they may employ, in part, the results of sample survey research, crime environment observation, or statistical analysis—and, as a result, use techniques which overlap with those considered in this chapter—base line studies are not reviewed here. The data they provide can, however, be of considerable value in subsequent countermeasure assessment within a particular urban area. Factors that can be measured in base line studies include:

1. Crime reduction.

   -- Number of transit-related crimes.
   -- Change in number, percent, or rate of different types of crime.

2. Victimization.

   -- Number of victims.
   -- Risk of passenger victimization.

3. Apprehension rates.

   -- Number of criminals apprehended.
   -- Rate of apprehension versus crime rates.

4. Ridership volume.

   -- Number of passengers.
   -- Frequency of use.

5. Transit revenues.

In addition to archival research and observation, survey techniques are sometimes used to acquire data for base line studies. Survey results can be useful in testing or establishing basic relationships between passenger attitudes and existing transit crime conditions. These include:

-- Passenger's overall feeling of security from criminal harassment and attacks.

-- Passenger's perceptions of the amount and type of crime in the transit system.

-- Passenger willingness to use public transportation versus other transportation alternatives.

-- Passenger's willingness to use transit during certain periods of the day.

-- Victimization experience of transit users.

-- Passenger consideration of personal security issues when deciding if (and when) to use the transit system (36).

Four broad categories of countermeasure assessment techniques are reviewed in the remainder of this chapter: observation, sample surveys, statistical analysis, and specialized interviews.

Observation

Observation, both of behavioral characteristics and the physical environment, can be an informal starting point for more rigorous examinations of countermeasure effectiveness. Behavioral observation is useful as a means of identifying patterns which occur within particular environments. It can be used to identify problems and also as a means of evaluating changes in behavior which result from certain events or the implementation of specific countermeasures. Although observation can generate useful data, the technique must be applied consistently and systematically. The measures of concern should be objective and descriptive.

Behavioral Observation

Observation is a site-oriented data collection approach which perhaps has been neglected, but which should be examined for possible use in predicting AGT system station security requirements. Observational measures allow the researcher to obtain data which are not subject to the same type of social-transmission-of-information reconstructions or distortions as data obtained by more obtrusive measures, such as interviewing or official record-keeping (89).

For example, the use of participant observation on CTA rapid transit lines led to the identification of the blocking phenomenon, in which some passengers use various means to prevent other passengers from sitting next to them (84). Not only were the observers able to document the frequency of the phenomenon, but they also identified systematic interactions between blocker and system characteristics. The use of observers can thus be effective in uncovering patterns of behavior which might not be elicited in interviewing. Observation does not have to take the form of direct human observations, but may also be accomplished through devices such as closed circuit television or time-lapse photography.

Observation can also be used to supplement other countermeasure assessment techniques. Use of this data collection method would require that consistent standards be used by all recorders. Without them, recorders would have a tendency to be led by the observed events and record only that which is of interest to them. Nevertheless, observation can be used to lend reality to data sources, and can play a key role in concert with other assessment techniques.

Transit operators could make extensive use of formal and direct observation as a data collection technique. Alternatively, as a supplemental data collection technique, observations can be informal and selective. In general,observations may be applied to a behavioral or physical setting. In this case, observation could be used to objectively record behavior in specific settings. It could be used to collect data on what activities take place, and who the actors are, in terms of visible characteristics, such as age, sex, and race. The first-hand collection of data of a contemporaneous event, such as a platform assault or purse snatching also allows the gathering of information which could increase the effectiveness of countermeasures.

For example, observed characteristics of offenders, victims, or circumstances could permit the testing of countermeasures which work effectively in adjoining neighborhoods where similar characteristics exist. Also, the ability to observe the above activities would enable the transit operator to follow up the observation, perhaps with the critical incident technique.

The objective of behavioral observation is to determine how people interact among themselves, or with the physical or transit environment. In general, both behavioral and environmental observation must be performed relative to a control situation or norm. This reflects a need to make the technique more systematic and objective. One of the major disadvantages of the observational method is the inability to control numerous environmental and social factors. It is also limited because the object or behavior being observed may occur infrequently or may not be easily observed. For example, observing criminal behavior may be difficult because, first of all, it is relatively infrequent, and secondly, the crimes are not usually committed in areas subject to easy surveillance.

Another limitation of the observation method is that it is not appropriate for substantiating causal relationships between two observations or conditions. Furthermore, it requires the careful training and supervision of observers and a clearly defined approach; in spite of this, it is prone to subjective interpretation. Finally, observational research is often labor intensive, and, therefore, expensive.

Behavioral observation may be a useful technique in identifying methods of social control evident in a given neighborhood. Based upon observation of behavioral responses to perceived crime or potential crime in a given neighborhood, desirable behavior patterns may be promoted in the transit environment by simulating these environmental settings or characteristics.

Environmental Observation

Some of the interpretive limitations of behavioral observation are less evident in environmental or physical observation. Here, the potential crime risks within AGT station areas can be carefully inventoried and analyzed. Two approaches with roots in CPTED analysis (36) seem promising: (1) the analysis of conventional transit/AGT system similarities and (2) the analysis of neighborhood gathering places/AGT stations similarities.

Comparing Conventional and AGT Station Environments

The first approach builds on much of the data this report has presented. An attempt should be made to isolate features of conventional transit which (1) have implications for crime and countermeasures and (2) are similar to AGT features. The analyst might consider, for example, the implications of the findings about the relative risks of the various phases of transit use shown in Table 13. (Table 13 was drawn, in turn, from a user attitude survey.)

Table 13
SCENARIO FOR RAPID TRANSIT SYSTEM USER

Action	Security Rank (Actual) (1)	Hazard Area/Factor
1. Arrival at Station	6	Parking lot
2. Enter Station	4	Stairways, escalators, elevators, etc.
3. Fare Collection	3	Handling currency
4. Waiting for Vehicle	1	Isolation
5. Entering Vehicle	5	Crowding
6. Riding	2	Isolation, unknown arrival environment
7. Exiting Vehicle	7	Unfamiliarity
8. Exiting Station	8	Stairs, escalators, ramps, etc.

(1) Based on actual crime frequency statistics.

Source: Adapted from Reference 77, page 17.

The analysis could proceed in terms of (1) the extent to which each phase is aggravated or mitigated in AGT as compared to conventional transit and (2) the types of countermeasures amenable for each phase's hazard. To be relevant at the site-specific level of analysis, the analysis of conventional transit/AGT similarities must rely on case study material.

The same is true for the analysis of neighborhood gathering place/AGT system similarities. The focus under this approach, however, should be on predicting the transferability of a particular neighborhood's crime countermeasures to an AGT station in that area. Again, the methodology should be keyed to the site-specific situation.

Transit-Related and Neighborhood Countermeasures

If traditional transit crime countermeasures are to be adequately supported by neighborhood countermeasures, the relationship of neighborhood countermeasures and transit must be understood. An examination of neighborhood countermeasures would show many relationships in environments similar to the transit environment. Many inner city neighborhoods have long suffered from the absence of services because of crime and fear of crime.

For example, gas stations are frequently closed at dusk because their operators fear robbery. This problem and the emergence of the self-service concept have led to a change in service patterns, and the development of countermeasures for gas stations, which should be of considerable interest to a transit system operating in that same neighborhood. An examination of these gas stations, now operating around the clock with effective countermeasures, would show many similarities to the transit environment. These stations have no attendants and gas is pumped by drivers. The cashier sits in an enclosure behind a double layer of bullet-proof glass, operates the pumps electrically, and handles cash through an opening only big enough to exchange currency. Previously, the cashier and attendants were under constant threat of holdup; with the present system of automation, this threat is eliminated.

Clearly, there are many similarities between this system of crime prevention and service, and that of an automated guideway transit system. Our limited field analysis had several surprising results. Similar neighborhood environmental observations could be conducted in specific cities considering AGT systems.

In this example, the gas station cashier feels very secure, but drivers do not. Interviews with drivers suggested several problems which transit operators should anticipate and plan for. As one gas station customer said, ''Sure this place is safe for the cashier but what about us drivers? When I come in this place I am always in a hurry to get my gas and get out.'' Another customer said, ''The customer is totally on his own now, no one to look to for help. How long do you think it will be before the robbers figure out that they cannot get to the cashier and start to come after us?'' These similarities and results should not go unnoticed.

OTREP Model

The OTREP model (36), as discussed earlier in Chapter 4, is an observational technique developed to assess the opportunity for crime in a given environment. Beyond the individual motivation to commit a crime, there are four situational factors which define the opportunities for crime: target, risk, effort, and payoff. Targets refer to those objects or persons subject to victimization by criminals. This could include transit personnel, passengers, personal property of passengers, or transit property. Obviously, it is impossible to eliminate all targets from the transit environment; nonetheless, there are some techniques, such as the Cash-Off-The-Street Project in Portland, Oregon, which can minimize or eliminate certain targets.

Risk describes the probability that the criminal will be punished or apprehended for criminal activity. As risk of reprisal becomes greater, criminals will be increasingly deterred from activity in that particular setting. This environment will also become less attractive to the criminal as the *effort* required to commit a crime becomes greater. Target hardening countermeasures are particularly effective in increasing the effort required to commit a crime. The final factor in OTREP analysis is *payoff.* This is closely associated with targets, but directly reflects the anticipated benefits of committing a crime.

The OTREP environmental assessment package includes a separate section for each of the four factors contributing to crime probability. Basically, the OTREP analysis compares a given environment to a control area. Before the analysis is performed, the observer must become familiar with both environments. The analysis is performed twice, once in the daytime and once in the evening. All observations of the target area are relative observations compared to the control setting. The first step in the analysis is to establish the context of the observation and the target site, including the surrounding types of buildings, behavioral settings, user characteristics, and identification of potential offender populations. Then, the four crime factors, target, risk, effort, and payoff, are examined relative to the control environment. Each analytical section lists a range of items to be considered. For example, under targets, the list includes money, private property, public property, wholesale/retail property, offices, and people.

Risk is associated with people and automobile activity in the target area, the actual physical environment of the site, the presence of law enforcement personnel, and the type, design, and access control of the building and residences in the surrounding area. The effort criteria is closely related to the maintenance of an area and the presence of target hardening devices, such as locks and barred doors. The payoff factor is primarily associated with the possibility of relocating or reducing crime targets.

The OTREP analysis briefly addresses a fifth factor which, in some cases, does not lend itself to on-site observation. This includes media coverage of crime in the target area and environmental cues reflected by that setting, such as cleanliness, attractiveness, and landscaping.

This form of observational analysis has not been widely used. It was developed and applied in the Crime Prevention Through Environmental Design studies and was applied on a test basis to school, residential, and commercial environments. The carryover to other urban crime environments, including conventional and AGT transit stations, would appear to be substantial.

Sample Surveys

Sample surveys may be used to obtain information about the respondent; information about past, present, or planned behavior; information about beliefs and attitudes; and personal interpretations of reasons underlying specific behavior. Surveys may be conducted of the population at large, residents of particular neighborhoods, transit users, or other specific groups. They can be based upon random samples or selective samples of different kinds. In any case, interviewers must be trained and the survey instrument carefully designed.

In the context of this study, surveys are most commonly employed to assess perceptions of the transit crime problem, attitudes toward different countermeasures, and selective opinions (including expert opinion) of the costs and benefits of specific countermeasures. Also, victimization surveys have been conducted to estimate actual crime rates versus the limited number that are reported.

Security Perception Surveys

Six noteworthy studies have been conducted in five U.S. cities addressing the public's perception of crime on transit and its effect on ridership (68). The studies included:

-- A Study of the Attitudes of Transit Users and Non-Users Toward Crime, Vandalism, and Passenger Security Problems and Their Relationship to Transit Patronage on Bus Route 60, Milwaukee and Suburban Transport Corp., Milwaukee, Wisconsin.

-- A Study of the Attitudes of Transit Users Toward Crime, Vandalism, and Passenger Security Problems and Their Relationships to Transit Patronage on the Pennsylvania Avenue/Wisconsin Avenue Bus Route, Washington, D.C., Metropolitan Area Transit Authority.

-- "Baltimore Patronage Study."

-- "Cleveland Patronage Study."

-- "Personal Safety Involving Victimization on Public Transit." (Chicago.)

-- "Chicago Transit Security Study."

Previous Surveys in Five Cities

In Milwaukee and Washington, D.C., a questionnaire was distributed along a specific bus route. In Washington, all questionnaires were handed out on transit, whereas, the researchers in Milwaukee augmented this technique by mailing questionnaires to a sample of persons residing along the transit corridor. The responses to these surveys were cross-tabulated in contingency tables to determine whether the evident relationships were significantly different than what could be expected in normal variability.

A less systematic perception survey patterned after the Milwaukee and D.C. efforts was conducted in Chicago by Ferrari and Trentacoste. This effort is overshadowed by the *Transit Security Study in Chicago* which addressed the entire CTA system. This was one of the most extensive studies of crime on transit conducted for the Chicago Transit Authority by Carnegie-Mellon University. It employed many of the data collection and analysis techniques which have been reviewed. Four primary research efforts were undertaken:

-- An extensive archival search collecting data on CTA ridership, operations, facilities, and crime.

-- Investigation of existing mass transit security techniques and devices on CTA.

-- Identification of the range of countermeasures possible on mass transit system.

-- A random survey of transit users to determine actual victimization rates and perceptions of crime on the Chicago transit system.

The CTA transit security study involved as one element, an extensive perception survey. This was conducted by random digit dialing and was administered to over 1,500 Chicago residents. Within this 19-page questionnaire, a scenario of rapid transit use was presented and the interviewee was asked to rank the different stages in the scenario by the amount of risk they perceived. In turn, these perceptions were related to actual crime occurrence.

The studies conducted in the Cleveland and Baltimore transit systems were attempts to determine the effect of criminal incidents upon transit ridership. These studies took on the character of base line analyses, comparing transit ridership statistics before and after a particular event.

Although the results of the different attitude surveys were not wholly consistent, tentative conclusions may be drawn regarding passenger perceptions of security and ridership behavior. First, transit crime exerts a strong influence on decisions to use the transit system, but this effect varies depending upon the volume of crime in the specific area, and the time of day the system is used. In general, security considerations more strongly influence decisions to use rapid transit than buses, and the influence of transit crime varies with local conditions. Other factors (such as frequency) were actually found to have a stronger influence on ridership decisions than specific crimes.

Usefulness in Evaluating Countermeasures

A crucial element for consideration in such surveys is the relative effectiveness of various candidate countermeasures in allaying patron fears and encouraging ridership. Several of the studies reviewed examined this area. The review by Siegel et. al (78) identified two strategies which appeared to bolster passenger confidence:

1. *Significant increases in police patrol* of stations and vehicles.

2. Implementation of improved *communication capabilities* to ensure rapid response of security.

Similar conclusions were reached, based on telephone interviews conducted in the Chicago transit security study (68). Respondents indicated three conditions under which they would feel more secure:

1. If they saw more police officers on platforms and trains.

2. If they knew quick assistance was available from CTA personnel or police.

3. If a policeman and dog were assigned to each bus or train during non-rush hour periods.

In a Philadelphia planning study for the redesign of a particularly unattractive and unsafe transit station near Temple University, students, residents, and other actual or potential patrons were asked how much safer each of eight possible countermeasures would make them feel (7). As shown in Table 14, these safety features included (1) police patrol approach, (2) technological devices, and (3) design features. Although the rank ordering of these countermeasure types by the respondents was the same as the order in which they are listed in the preceding sentence, the most striking finding to emerge from the table is that *all of the countermeasures were rated highly in terms of enhancing feelings of personal safety.* In fact, the difference between the mean ratings of the most desirable (full-time safety guards) and least desirable (attracting greater number of people to the station area) of the individual countermeasures is approximately the difference between feeling very much safer and feeling much safer. Clearly, there is not a great deal of differentiation provided by such clustering nor much reason for selection of a particular measure based solely on this criterion.

Differences between perceived and actual security risks can also be derived via transit user surveys, and used as a guide both in transit system design (including AGT systems) and countermeasure assessment. Table 15 represents an extension of Table 13 to show such differences, based on Chicago data (77). Note that perceived security risks are associated primarily with entering or leaving the station, and secondarily with waiting for and riding on transit vehicles. Discrepancies between perceived and actual security ratings are striking for "waiting for vehicle," "riding," and "exiting station." The extent to which countermeasures specifically address those factors most feared by users can be a key element in their evaluation.

"Panel of experts" survey techniques also may be used to evaluate overall countermeasure effectiveness as in the University of Virginia study (30). A panel, comprised of informed individuals, was asked to rank a variety of countermeasures as being high, medium, or low in cost, relative to the acceptability of the technique to transit riders and transit operators. These responses were averaged in a table comparing the different countermeasures and their capital and operating costs. The panel also was asked to evaluate the effectiveness of particular countermeasures in light of certain crimes. Each countermeasure was given a rating of effective, marginally effective, or ineffective. Once again, scores were averaged and a final matrix was developed. (Results are discussed in Chapter 9.)

In general, this form of analysis supports the conclusions of Sidley and Shellow in their extrapolation of knowledge of rapid transit crime experiences to automated guideway systems (77). Based upon their analysis of system features related to crime occurrence, perceived and actual risks (Table 15) and the characteristics of transit crime, they concluded that in choosing system countermeasures, it was most important to design a surveillable system. Secondly, the operations of the transit system should attempt to minimize waiting time in stations. Finally, all attempts should be made to facilitate the detection of actual crimes and to speed the response of security personnel (10).

Table 14
MEAN RATINGS OF PROPOSED SAFETY FEATURES

Item	Mean(1)
1. Full-time safety guards (policing strategy)	4.06
2. Platform level alarm system (technological device)	3.74
3. Closed circuit TV monitoring of platform area (technological device)	3.49
4. Elimination of hidden corners (design feature)	3.27
5. Improved lighting of station area (design feature)	3.15
6. Open-air design (design feature)	3.06
7. Shortening of platform length (design feature)	2.91
8. Attracting greater number of people to the station area (design feature)	2.85

(1) Means were computed from ratings by approximately 500 respondents of each proposed countermeasure on a scale from one to five as follows:

1. No safer
2. Slightly safer
3. Much safer
4. Very much safer
5. Extremely safe

Source: Adapted from Reference 7, page A3.

Table 15
PERCEIVED SECURITY SCENARIO FOR GUIDEWAY TRANSIT SYSTEM USER

Action	Security Rank Perceived	Actual	Hazard Area/Factor
1. Arrival at Station	--	6 (L)	Parking Lot
2. Enter Station	1 (most dangerous) (H)	4 (H)	Stairways, Escalators, Elevators, etc.
3. Fare Collection	--	3 (H)	Handling Currency
4. Waiting for Vehicle	3 (L)	1 (H)	Isolation
5. Entering Vehicle	--	5 (L)	Crowding
6. Riding	3 (L)	2 (H)	Isolation, Unknown Arrival Environment
7. Exiting Vehicle	--	7 (L)	Unfamiliarity
8. Exiting Station	1 (H)	8 (L)	Stairs, Escalators, Ramps, etc.

(H) = High ranking
(L) = Low ranking

Source: Reference 77.

Another area where surveys can be utilized is that of passenger perceptions regarding the magnitude of transit crime (subjective crime rates, SCR). If passengers perceive a greater magnitude of transit crime than actually exists (estimated crime rate, SCR, based on extrapolation of police records or victimization surveys), this might indicate the existence of many negative cognitive factors, such as poor maintenance—conditions which could be altered with only moderate effort or cooperation (36).

Victimization Surveys

Victimization surveys are much like general population surveys, except that they are designed to develop an in-depth characterization of the crime-victim relationship. Such surveys attempt to gather information which is not normally collected in police reports or other crime-oriented reports or statistics. Information is sought about the personal, social and economic characteristics of the victim, particularly as they relate to crime events, and is generally collected through personal interviews and/or questionnaires.

The survey usually focuses on the "bona fide" victim. Thus "victimless" crimes (drunkenness, drug abuse, prostitution, gambling, etc.), and crimes without specific victims (such as white collar crimes) are often excluded. Also excluded from assessment are those crime victims who possess little detailed information about the crime (such as attempted crimes and some cases of fraud or embezzlement), or victims who have played some role in perpetuating the crime (blackmail, con games, some types of swindle, etc.).

Victimization surveys offer an opportunity to specify the characteristics of crimes, offenders and/or victims. Through time series analyses, risk relationships, frequency and change-over-time assessments can be made. Further, such studies can often provide important insights about the causes of crime, victim selection characteristics (or their actions which precipitated selection), and the development of preventive tools and techniques.

Sinha, et. al., (79) used a victimization survey to examine personal security on bus transit vehicles and its effect on ridership. The survey was conducted in Milwaukee along a bus route that experienced high occurrences of transit crime and vandalism, even though the route transversed a cross section of land-uses and neighborhood types that varied in socioeconomic levels.

Bus riders and households along the chosen corridor were sampled; bus riders were interviewed on the bus and households received a mailed questionnaire. The results were examined to determine the relationship between passenger perceptions regarding the incidence of crime and vandalism and reality. The responses were cross tabulated by rate of transit usage, age, sex, type of land-use and socioeconomic characteristics of the sampled zones.

The Law Enforcement Assistance Administration (LEAA) and the Bureau of Census (57) jointly implemented a victimization survey to compare personal, household, and commercial victims of crime in two cities in California. Approximately 5,500 households were sampled to determine the incidence and character of personal and household victimization, and more than 1,000 business establishments and organizational units were examined to determine the incidence and character of commercial robbery and burglary. Personal interviews using questionnaires was the method by which the survey was implemented.

Statistical Analysis

Statistical analysis is actually a method of manipulating data generated by the archival, observation, or survey techniques. Thus, in itself, it is not a method of obtaining primary information and, therefore, should be distinguished from the previous techniques. Given the statistical method to be applied, a researcher can determine the most appropriate methodology for acquiring the necessary information. Some of the data collection techniques cannot generate the type and form of data required for certain forms of analysis. In some cases, the techniques do not permit the control of exogenous variables to the necessary degree. In particular, the observational technique does not lend itself to control of environmental or behavioral factors. Rather, the method and observers themselves, must be controlled.

The initial step in any quantitative analysis must be to test the reliability and validity of data. Reliability implies consistency, both over time and for different researchers/observers. Validity, on the other hand, implies accuracy, both in recording information and obtaining data which is truly representative of the condition it is sought to describe.

In quantitative analysis, there are a number of basic manipulations and initial investigations which should be conducted to gain insight into the nature of the variables. First of all, information is frequently converted into rates or indices which permit comparison over time or between two different environments. Examples of such rates are empirical crime rates (ECR), crime ridership indices, exposure indices (EI), and subjective probability of victimization roots (SPV). These indices are described in greater detail in subsequent sections.

Besides converting information into rates or indices, it is valuable to calculate descriptive statistics for the different variables. These should include raw frequency distributions of observations and frequency distributions by factors such as time, type of crime, and location. It is also useful to plot crime and environmental data on maps and overlay appropriate information to see if spatial correlation exists. Such associations would not be readily apparent in other forms of analysis. Finally, another basic form of analysis includes cross tabulation. This will identify any significant correlations between variables.

In summary, the basic level of analysis includes calculating specific rates or indices, review of descriptive statistics, frequency distributions, mapping, and cross tabulations. These techniques can be extremely informative and may suggest more sophisicated statistical methods which could be used to investigate indicated relationships.

Indices

Compilation of certain statistical data permits the derivation of crime indices which compare crime on transit to crime on the streets and crime rates between different stations within the same system. One formulation of a crime/ridership

index is produced by dividing the incidence of specific crime over a specified time period by the number of passengers entering the transit system during that same time. This index may also be derived based upon the estimated daily rapid transit population. In the latter estimation, the base of the index would be smaller because multiple users would be counted only once. To generate a comparable statistic for street crime, a particular crime rate (i.e., for robbery) is taken relative to the city's population. This discussion merely suggests the methodological problems associated with comparing street crimes to transit crimes. In both indices, the denominators are subject to dispute.

Thrasher and Schnell (85) in an attempt to quantify the extent and seriousness of crime and vandalism on urban transit systems, developed another index related not only to the number of crimes relative to the base population, but also to the amount of time spent within the transit system. This index, the exposure index, was generated by estimating the average trips per person per year in the transit system. This figure was then multiplied by 15 minutes, the estimated average trip length. The resulting figure was then divided by the number of minutes in a year to give the average percent of time per year that a person was in the transit system and thus, exposed to transit crime. The second step was to divide the total incidents in a given crime classification by the population to get an average figure of crimes per person. Finally, the crime rate was divided by the exposure index to produce a transit crime exposure index which could then be compared to the FBI violent crime index and total crime index.

Conclusions drawn from two different index comparisons (both based upon Chicago information) produced contrary results. In the Schnell study, it was concluded that the chance of being robbed in the transit system was one-third as great as that in the rest of the city. In contrast, the exposure index calculation reflected that the risk of being involved in a criminal incident was two times greater when riding on a transit system than in non-transit environments.

Inconsistent conclusions from these analyses is symptomatic of the problems which can be encountered with index calculations. Many formulations for the different indices may be rationalized. Nonetheless, despite these drawbacks, indices provide one of the few techniques of translating archival data into a form which permits comparisons between non-similar environments.

Comparative Analysis

Perhaps one of the most common forms of statistical evaluation is comparative analysis. This can refer both to comparisons between different situations or to comparisons between different times. Respectively, these may be referred to as cross-sectional analysis and longitudinal analysis. Cross-sectional studies involve the comparison of non-equivalent groups. Although many of the conditions or characteristics of an environment may be similar, the mere fact that they are unique situations (perhaps, due to socioeconomic or physical characteristics), introduces uncontrolled elements into the study design. In contrast, longitudinal studies permit more control over the particular environment. However, in this case, time and its associated changes represent the uncontrolled variables. Nevertheless, longitudinal studies avoid the problem of identifying a closely comparable setting.

Longitudinal studies are a simple form of time series analysis. In a strict sense, time series analysis has more stringent data requirements than the comparative analysis. For time series, comparable numeric data must be gathered over a period of time which permits trends to appear. Thus, it is not appropriate for comparing two single points in time. Rather, it is used to establish the existence of periodicity in the data. Thus, it may be most appropriate for identifying trends in crime over the course of years, seasons, or days. For example, if daily crime statistics were gathered for a given system or station for an entire year, weekly cycles could be described. Alternatively, if the relative crime rates in different seasons for the year were of interest, crime characteristics for each month could be gathered for several years and the pattern idenfified.

Relational Studies

Another form of statistical analysis concerns relationships between variables. The data requirements of this technique are not as rigorous as those required for more sophisticated analysis, such as time series and regression. For example, dichotomous variables (i.e., sex) are sufficient for X^2 tests. These techniques can identify correlations between different variables, however, they do not help to explain the causal relationship between different factors. The explanation for apparent relationships must rely upon common sense and speculation. Rank ordering is another relational analysis which often draws upon perception surveys for rare data.

For example, in the Chicago Transit Authority's perception survey, countermeasures were ranked according to how much they were perceived to bolster public confidence. Comparable surveys have been conducted in other transit environments (Philadelphia) and similarly respondents ranked proposed security features in terms of their perceived effect. Overall, as mentioned earlier, sizeable increases in police deployment in both stations and vehicles had the most positive effect on passengers perceptions of security. The provision of communication and surveillance devices which facilitate police response was the second most desirable improvement. Tables 16 and 17 offer examples of the results of such rank ordering analyses.

Relational indices have also been developed to correspond to the seriousness of specific crimes. A rank ordering of the seriousness of crimes or crime categories can be derived from perception surveys and possibly factor analysis (a means of synthesizing the vast number of crimes into composite groups). A ranking system for crimes has been developed at the University of California-Berkeley and is called the Crime Severity Index (CSI). This has been utilized in the "AGT Systems Safety and Passenger Security Study" being conducted at the University of Virginia (30). Once the incidence of crime is determined from archival research or predicted using regression models, the rates can be weighted by the CSI to establish priorities for countermeasure implementation.

Table 16
ILLUSTRATIVE RANKING OF TRANSIT COUNTERMEASURES

Rank	Improvement Item	Mean Rank
1	Increase the Number of Police at Stations	3.15
2	Increase the Number of Police on the Vehicles	3.24
3	Initiate a Communication Network	3.29
4	Initiate an Alarm System	3.62
5	Improve the Station and System Lighting	4.31
6	Increase the Frequency of Cars	4.52
7	Improve the Neighborhood Surrounding the Stations	4.72
8	Increase the Passengers Per Car by Reducing the Number of Cars Per Train	5.91

Source: Reference 78, p. 221.

Table 17
ILLUSTRATIVE RATING OF TRANSIT COUNTERMEASURES

	Item	Mean
1.	Full-time Safety Guard	4.06
2.	Platform-level Alarm System	3.74
3.	Closed-circuit Television Monitoring of Platform Area	3.49
4.	Elimination of Hidden Corners	3.27
5.	Improved Lighting of Station Area	3.15
6.	Open Air Design	3.06
7.	Shortening Platform Length	2.91
8.	Attracting Greater Number of People to the Station Area	2.85

Scale of 1 to 5:

1 = No Safer
2 = Slightly Safer
3 = Much Safer
4 = Very Much Safer
5 = Extremely Safe

Source: Reference 7.

Causal Analysis

"Causal" analysis requires data to be of an interval or ratio scale. Multiple regression analysis is the most common technique in this category, as reviewed earlier in Chapter 7. This form of analysis has most frequently been applied to predicting crime, rather than evaluating countermeasures. Controlled experimentation, on the other hand, is a technique which may be used to imply causal relationships between countermeasures and improved security. Once again, the requirements of this form of analysis is quite rigorous, not only in the form of the variables, but also in the situation observed. It is necessary to have two comparable groups and to control all critical factors. In one group, a single factor is altered, and the impact evaluated relative to the control setting. If differences are observed in the altered environment, a causal link between the adjusted factor and the resulting conditions is implied. This association must be tested numerous times in order to confirm the significance of the implied relationship.

Although a desirable technique, the transit environment does not lend itself to controlled experimentation. There are too many factors in the physical and socioeconomic characteristics of transit stations which cannot be controlled by the researcher. Attempts at controlled experimentation have been made in New York relative to the effect of various police deployment strategies (7). Also, a study is presently being conducted by Dunlap and Associates in New York to determine the effect on crime and perceptions of crime of installing closed circuit television (30).

Dunlap identified two transit stations which are located in neighborhoods with similar demographic characteristics. Both stations are terminal stops for a transit line and both pass through ghetto areas enroute to this terminus. Eight closed circuit television cameras have been installed in one of the stations and are monitored by the police station which is also housed in the transit terminal. Considerable publicity accompanied the installation of the closed circuit television and the cameras will remain in operation for one year.

Prior to the closed circuit television publicity and installation, questionnaires were distributed to a random sample of the population around both stations. This will provide base line information for the study. One station will not have cameras installed and will serve as a control for the analysis. Six weeks after the installation of the cameras, a follow-up questionnaire was completed in both areas by another random sample. A third follow-up survey will occur in three to four months. The samples have been systematically selected and will include 5,000 households in each study area. The random samples will be selected without replacement, therefore, no person would fill out more than one questionnaire in the course of the study.

The main problems regarding the design of this study are: (1) there is no control for the fact that the station in which closed circuit televisions will be installed also has a police station within the structure and (2) there is also no way to separate the effect of publicity from the solitary effect of installation of closed circuit television cameras. Although the emphasis of the study is on the perceptual impact of a specific countermeasure, the actual crime rate reduction also will be examined in light of traditional police records.

Specialized Interviews

Key Person Interviews

The key person community analysis process is a technique for dealing with problems of access and validity in doing research in difficult environments, e.g., those in which residents are reluctant to be interviewed or in which interviewers may be uncomfortable. It incorporates elements of both field work and survey research. Similar approaches have anticipated the key person community analysis process, including the experience survey and informant strategies (3, 9, 23, 70, 91). By applying field work techniques which previous investigators have used to supplement the survey, it provides a correction for some of the limitations of traditional survey approaches. In effect, the key person process is part of the survey family but adds some field work approaches to sample selection, access, and interviewing.

Through the cooperation of key persons in the community, the process allows the researcher to integrate participant, observer, and "stranger" strategies. The process may be truncated at various points, depending on the purpose and scope of the study. In addition to its research role, it has potential for citizen participation, community resource mobilization, and the development of program recommendations.

The key person process has been applied in transit planning projects. The information acquired provides a base from which the assessment of other data collection approaches may proceed. For example, preliminary assessments of the key person interview process as compared with archival data and sample survey data, are presented in Table 18. This table is drawn from a study of transit-dependent persons in St. Louis, where several data sources were analyzed to determine the travel characteristics, needs, and perceptions of this transit user group.

Interview Process

The key person interviewing process has three major steps:

Step 1: Meetings are held with leaders of the key community organizations in the neighborhoods. The research is then explained, along with specific interview needs. These meetings are solely explanatory; no data are collected until it is clear that the person(s) involved endorse the effort. Those in attendance are then asked to name other persons in the neighborhood who are influential. Whenever possible, each is asked to personally introduce the interviewer to that person; short of that, a telephone introduction will be made.

Table 18
ILLUSTRATIVE STRENGTHS AND WEAKNESSES OF DATA SOURCES

Area of Analysis	Data Strengths	Data Weaknesses
Location of Transit-Dependents	E.D.: More detailed zonal breakdown; statistical reliability. K.P.: Adequate large-district results.	E.D.: 1970 census out of date. K.P.: Based only on generalized perceptions.
Trip Purpose	E.D.: Detailed statistical breakdown for all socioeconomic groups. T.D.: More detailed and reliable statistical breakdown for transit-dependent groups. K.P.: Adequate ranking of trip purposes.	E.D.: Tends to underrepresent transit-dependent groups. K.P.: Statistical analysis not possible.
Major Travel Corridors	E.D.: Establishes major transit ridership corridors and linkages.	T.D.: Not suitable for identifying major travel corridors. K.P.: Not suitable for identifying major travel corridors.
Daily Travel Time Budgets	E.D.: Detailed statistical breakdown for all socioeconomic groups. T.D.: More detailed and reliable statistical breakdown for transit-dependent groups.	E.D.: Tends to underrepresent transit-dependent groups. K.P.: Not applicable.
Mode Choice	E.D.: Detailed statistical breakdown for all socioeconomic groups. T.D.: More detailed and reliable statistical breakdown for transit-dependent groups.	E.D.: Tends to underrepresent transit-dependent groups. K.P.: Not applicable.
Latent Demand	E.D.: Comparison of trip rates permits derivation of *hypothetical* latent demand. T.D.: Probes *perceived* latent demand.	K.P.: Results too generalized to be useful.
Desired Transit Improvements	T.D.: More detailed list of possible improvements. K.P.: Reflects informed opinions of community experts.	E.D.: Limited list of possible improvements. K.P.: Does not directly reflect transit-dependent preferences.

Note: E.D. = Existing Data; T.D. = Transit-Dependent Survey; K.P. = Key Person Community Survey.

Source: W.V. Rouse & Co., *Transit Needs Analysis*, Vol. II: Procedure Manual, East-West Gateway Coordinating Council, St. Louis, November, 1977.

Step 2: The interviewer returns to conduct background interviews with the key people. These interviews use open-ended questions and generally vary in length, depending upon the respondent. The objective is to develop knowledge of the neighborhood—its resources, local conditions, and other important issues and information pertinent to the research effort.

Step 3: In a short time, word spreads regarding the researchers and the research effort. Sometimes, key persons mention friends that ought to be interviewed. More often (and more economically), key persons give entree to members of a block organization, a housing development, or some other group. The objective is for the interviewer to be brought in contact with members of the community through a credible endorsement from a known source.

A new referral is sought with each new interview. Eventually, it becomes known that the researchers are primarily interested in persons who have had direct, personal experiences with the issues of concern. At this point, we are at the neighborhood level, the level at which a broad range of respondents can be tapped. The key persons are likely to refer the researchers to people who, while not leaders, are more involved in community affairs than the typical citizen. In turn, *that* person is likely to introduce more or less ''ordinary'' members of the community, and from that point, the researchers unavoidably hook into friendship networks. Nevertheless, these are likely to span the range of community opinions.

Statistical Disadvantages

It should be clear that this is a far-from-random process. However, the issue is not whether the sample is biased, but whether the dimensions of bias are ones that operate against the research purpose. Without a doubt, this process achieves a disproportionately large representation of the leadership group—but it is a group best able to define the community, identify the issues, and represent the views of residents.

It is uncertain whether the key person interviewing process is inferior to conventional research techniques, even if these were an option. The sample is weighted toward the community's activists, the more visible members of the community, and probably those more aware than the average resident.

Pragmatic Advantages

Nevertheless, the process has unmistakable virtues: (1) respondents generally accept that researchers are there in good faith and for a legitimate purpose; (2) the sample includes the people who are most knowledgeable about the issues in question; and (3) the sample includes a full range of respondents living in the neighborhood.

As mentioned previously, another important virtue of the key person interviewing process is that the findings can be used to test the reliability and particularly the validity of documented data materials. Given the severe handicaps posed on the use of conventional research techniques in difficult research environments, the reliability and validity of findings derived from the use of such techniques is often questionable. The key person interviewing process keeps the research effort at a microlevel of examination, a level that conventional techniques seldom reach. The findings derived by this process can lend credence to findings generated about the general community. When archival data research and key person techniques are both used in a community analysis, a heavier weight is attributed to key person findings than findings from other data sources when the information is reconciled.

Application of the key person interview process in the analysis of transit crime and countermeasures would appear to have strong potential in those high-crime neighborhoods which also display significant levels of transit crime. It is in these same kinds of lower-income, economically disadvantaged neighborhoods where the use of conventional research techniques in other social science contexts has met with difficulty. Key person interviews focusing on transit crime could address particularly locally *perceived* levels of crime (and threat of crime), as related to the different components of transit usage (waiting, riding, etc.). A probing of the *expected* effectiveness of countermeasures, and even the identification of neighborhood-oriented countermeasures (Chapter 6), could also be undertaken.

Critical Incident Technique

The critical incident technique (18) was developed over two decades ago. Since then, it has become one of the most widely known and used procedures for determining critical section requirements, producing test rationales, establishing performance standards and training needs, and developing criteria for evaluation purposes. A critical incident is a description of a behavior or event which clearly made a significant impact upon the respondent. The description must be complete enough to permit inferences to be made about the behavior described.

The critical incident technique requires participants to provide detailed descriptions of effective and ineffective actions in particular circumstances. For example, participants could be asked to think of their most recent positive or negative experience with the transit system. They would be asked to describe in precise terms:

-- The specific situation and factors leading up to it.
-- The specific behavior performed that led to the effective or ineffective results.
-- The specific reasons this led to the results.

The same procedure would be repeated for other recent events that led to effective results. Participants would then be asked about the circumstances which led to negative outcomes. Specific descriptions of the factors, behavior, and reasons surrounding the ineffective performance would be elicited, and the procedure repeated as before.

The effectiveness of the critical incident approach derives from two major characteristics. First, it distills from the countless number of observations that individuals make in the course of their daily lives those that are "critical" in producing certain, significant outcome. Respondents are asked to report events that meet this criterion of tangible, significant consequences. Reports that do not meet it are discarded from the data.

Secondly, general impressions or generalizations are excluded. The data take the form of discrete, unrelated events; the conclusions emerge from the composite of data collected from many different respondents. This emphasizes the function that humans perform reliably: the report of factual observations that they have made in an area of special concern. It eliminates the generally unreliable task of drawing generalizations. To the best of our knowledge, it is the most effective method available for converting observations to objective, reliable data.

Respondents are asked to report the most recent events they can recall, preferably those that occurred within the past few days. This specific "time segment" approach is used to elicit the complete range of pertinent observations. It avoids the restricted range that is obtained when the respondents only report the most dramatic events they can remember. The questions asked by the researcher to elicit responses are general, including a minimum of substance in order to avoid biasing the results and predetermining directions. For the same reasons, examples of incidents are never included in the instructions. Incidents can be collected in key person interviews or group administered questionnaires.

Chapter 9
INTEGRATION OF TECHNIQUES

Countermeasure Evaluation: Present Limitations

Transit countermeasures are designed to accomplish one of three purposes: (1) deter crime, (2) increase the likelihood of criminal apprehension, and (3) prevent the execution of crimes. In general, the ultimate goal is to reduce crime, the growth rate of crime, or to improve the perception of safety within the transit system. Consequently, the overall effectiveness of countermeasures must be measured against these basic objectives, as well as against practical implementation considerations. Assessment techniques should be judged relative to their ability to rate countermeasures in terms of:

1. Effectiveness.

   a. Actual.

      -- Reducing crime.
      -- Increasing ridership.

   b. Perceptual.

2. Adaptability/flexibility (ability to be interfaced with other countermeasures and adapted to changing crime trends).

3. Cost.

4. Acceptability.

   a. Transit users.
   b. Transit personnel.

Unfortunately, as discussed at the end of Chapter 7, the present state of our knowledge about most countermeasures is fragmentary. Even costs can vary significantly according to the details of implementation, and the availability of data

to judge effectiveness has been quite limited. Cross-city comparisons which would be quite useful in the context of this report, have proven very difficult.

Consequently, because relatively little is really known about countermeasure costs, effectiveness, adaptability, and acceptability, it is even more tenuous to consider an assessment of the analysis techniques which might establish these countermeasure characteristics. The techniques have, by and large, yet to be used. The various observational, survey, statistical, and interview techniques reviewed in the previous chapter are only now *beginning* to be applied or considered in the context of transit security analyses (let alone AGT security analyses, specifically).

The approach to comparing crime prediction and countermeasure assessment techniques taken in this chapter is necessarily judgmental. A framework is developed for comparison which does begin to suggest how some techniques might be preferred over others. Preliminary recommendations can be made. However, as additional experience is gained in implementing specific countermeasures, as well as the methods for analyzing them, these preliminary findings should be reassessed, clarified, and extended.

The following criteria are used to rate countermeasure prediction/assessment techniques:

-- Data requirements.
-- Cost (generalized).
-- Technical expertise required.
-- Time required to complete.
-- Reliability.
-- Validity.

Examples of Preliminary Countermeasure Assessment

Before comparing countermeasure assessment techniques along these lines, it is useful to review the extent to which judgmental rating has dominated two recent attempts at countermeasure evaluation. In one example, judgmental scores are assigned to transit station (AGT or conventional rail/bus) characteristics involving primarily the external environment. In the other, judgmental scores are assigned to more specific countermeasures oriented toward the details of internal station functions. In both cases, the rating method used involves elements of "security perception surveys" and "relational studies," as described previously in Chapter 8.

These judgmental methods, which could involve participation by technical staff, panels of experts, transit decision-makers, transit patrons, or neighborhood residents, are especially attractive for several reasons:

-- They require very little data, and, in fact, circumvent the extensive data problems associated with more vigorous attempts at countermeasure analysis.

-- They can be implemented quickly.

-- They are relatively low in cost.

-- Where decision-makers, transit patrons, or neighborhood residents are involved, a diversity of attitudes and perceptions can be tapped.

-- They can provide focus for identifying key trade-offs among different countermeasures, where additional data might be needed or consulted.

-- They do allow a wide range of potential impact or acceptability factors to be at least considered and explicitly addressed.

While these are important virtues within the time frame and data availability constraints of major local transit planning and engineering projects (including AGT), the limitations of such methods should be recognized. In effect, they correspond to "sketch planning," in the sense that few details or specifics are really considered, particularly with respect to costs. Wide latitude in all of the judgmental ratings is implied. Because of this coarseness, it is possible that, for specific AGT systems and/or stations within those systems, at a project planning level, more detailed consideration of specific countermeasures would yield significantly different results. Consequently, the reliability and validity of such generalized rating methods are not high.

External Station Design/Environment Ratings

The Institute of Urban and Regional Development at the University of California-Berkeley has developed a rating method which, by implication, evaluates the effectiveness of countermeasures and produces a transit station security score based on "context" variables (30). Station characteristics are scored individually on a scale of one (low) to three (high, more secure). Then, scores are totaled to produce a rating which reflects the relative safety of different transit stations. Table 19 lists the different factors by which individual transit stations could be rated.

Internal Station Countermeasure Ratings

A systematic form of judgmental countermeasure evaluation has also been conducted by the University of Virginia in the *AGT Systems Safety and Passenger Security Study* (30). To set the stage for the discussion of countermeasures and to identify special crime factors, a number of scenarios were developed in that study to exemplify transit crime. Then, a broad spectrum of countermeasures was reviewed in terms of general characteristics, their potential application to AGT systems, and their costs.

First, each countermeasure was given a rating by a panel of experienced transit personnel corresponding to its anticipated acceptance by passengers, transit employees, and its acceptability in terms of capital and operating costs. Thus, each countermeasure received four acceptance ratings, each being either H, M, or L. (see Table 20).

Table 19
GENERAL STATION SECURITY RATING METHOD

Indicator	Score
Station Elevation	
Surface	2
Subway	1
Aerial	2
Number of Levels (Including Street Level)	
Two	3
Three	2
Four	1
Passenger Volume (Estimated ADT for 1975)	
0 - 10,000	1
10 - 25,000	2
More than 25,000	3
Line Situation	
Through	1
Transfer	1
Terminal	2
Trip Attraction/Generation	
Attractor	1
Generator	3
Balanced	2
Predominant Land-Use Immediately Surrounding Station	
Suburban	
-- Residential	3
-- Commercial	2
-- Mixed	2
Urban	
-- Residential	2
-- Commercial	1
-- Mixed	1
Industrial	1
Freeway	1
Vacant, rural, or agricultural	1

Table 19 (Cont'd)
GENERAL STATION SECURITY RATING METHOD

Indicator	Score
Land-Use Density Immediately Surrounding Station	
Low	3
Medium	2
High	1
Parking	
No	2
Yes	1
Number of Paid Area Exits	
One	3
Two	2
Three or more	1

Note: The General Station Score of a particular station for security would then be the sum of its scores in each individual category (the higher the score, the better the security).

Source: Reference 30, taken from University of California at Berkeley, *Methodology for the Design of Urban Transportation Interface Facilities*, U. S. Department of Transportation, 1976.

Table 20
ILLUSTRATIVE COUNTERMEASURE ACCEPTABILITY AND COST RATINGS

	COSTS			
	Acceptance Costs		Monetary Costs	
COUNTERMEASURE	Objectionable to Transit riders	Objectionable to Transit Operators	Capital Costs	Operating .Costs
Pre-Screen Riders	H	H-	M+	H
Alarms & Sensors	L	L	M	M
CCTV	L	L	H	M
Voice Monitors	L+	L	M	M
Barriers	L+	L	M	L
Sealed Exits	M	L+	L+	L
Fare Box "Hardening"	L	L	M	L
Good Lighting	L	L	M	L+
Open Station	L	L	M	L
Climate Control	L	L	M	M
Adaptive Space	L	L	M	L+
Attractive Environment	L	L	M-	M
Restroom Restrictions	M+	L+	L	M-
Single Exits	H	L	L	L
Community Relations	L	M-	L	M
Police Patrols	L-	L	L	H
Vehicle Deployment Strategies	L	L	M-	M
Canine Patrols	L+	M-	L+	H
Aerial Surveillance	L	M	H	H
Reduced Service	H	L+	L	L
Legal Sanctions	L	L+	L	M+
Land Use Considerations	L	M		L
Teleview Alert System	L	L	H	M

H = high M = medium L = low/little

Source: Reference 30.

Second, countermeasures were evaluated by a panel of experts to determine their overall effectiveness, both in terms of crime reduction and acceptance relative to certain crimes (see Table 21). A third element of the evaluation and selection technique was to weight the anticipated crimes by their perceived importance and severity.

Ultimately, a method for integrating these countermeasure evaluations was devised. It was based upon the assumption that by using crime statistics and crime problems, the anticipated types of crime in an area could be identified. By using the effectiveness matrix, the countermeasures most useful in combatting the anticipated crimes could be identified. Then, the effectiveness of each countermeasure was preliminarily evaluated in terms of crime scenarios and implementation costs.

Integrated Methodological Approach

Because of the limited experience to date in applying the various countermeasure assessment techniques reviewed in Chapter 8 to urban transit (and AGT) contexts, it is premature to develop recommendations regarding the application of specific techniques. All of the techniques reviewed would appear to have some application, and additional experience is essential in clarifying their costs, data requirements, and reliability in a transit planning/engineering setting. Recommendations can be developed, however, regarding a *general framework or approach* for applying such techniques within a specific urban area. Given the time, budget, and staff skills available, local agency planning/engineering staff will find that some techniques are more attractive than others.

Comparison of Assessment Techniques

A fundamental basis for comparing the different countermeasure assessment techniques involves the six criteria listed earlier in this chapter. Table 22 offers a generalized, subjective review of the different techniques according to these criteria.

In general, the *statistical techniques* score well against all of the criteria. This means that they offer relatively high statistical reliability and validity, but only with moderate to high costs, significant data and technical expertise requirements, and generally several weeks or months (or more) of elapsed time for completion. *Observational* and *specialized interview* techniques, on the other hand, receive low to moderate ratings on all criteria. These methods offer reduced costs and technical requirements, but at the sacrifice of statistical reliability and validity. Falling between these extremes are *sample surveys,* particularly security perception surveys, where both the level of effort and costs, as well as statistical acceptability, can vary.

Table 21
ILLUSTRATIVE COUNTERMEASURE EFFECTIVENESS RATINGS

	CRIMES	GOOD LIGHTING	"OPEN" DESIGN	CLIMATE CONTROL	ADAPTIVE SPACE	VISIBLE, UNIFORMED SECURITY FORCE	MEDIUM-VOLUME TRAFFIC FLOW	SCHOOL/COMMUNITY PROGRAMS	ATTRACTIVE, CLEAN TRANSIT PROPERTY	REDUCE NO. OF CARS DURING OFF-PEAK HOURS	PRE-SCREEN RIDERS	ELIMINATE STATION RESTROOMS	TRANSLUSCENT DOORS IN RESTROOMS	PNEUMATIC TUBES TO COLLECT END-OF-DAY RECEIPTS	VOICE MONITORS	C.C.T.V.	PASSENGER ACTIVATED ALARMS	ALARM ACTIVATED VIDEO-TAPE	BURGLAR-TYPE ALARMS	PUBLIC ADDRESS SYSTEM	TELEVIEW ALERT SYSTEM	METAL DETECTORS	K-9 PATROLS	PRESENCE OF TRANSIT PERSONNEL	PLAIN-CLOTHES DETECTIVES	SATURATION PATROLS	POLICE DECOYS	NON-SCHEDULED TRAIN STOPS	AERIAL PATROLS	NON-BREAKABLE WINDOWS	VANDAL PROOF SEAT COVERINGS	CLEANABLE, GRAFITTI PROOF SURFACES	AUTOMATICALLY-SEALED EXITS	SINGLE EXITS	PREVENTION OF FARE EVASION
AGAINST PERSON	ASSAULT	/	/	/	/	x	/	0	0	/	/	0	0	0	/	x	/	/	0	/	/	/	x	x	/	x	/	/	0	0	0	0	/	/	0
	BATTERY	/	/	/	/	x	/	0	0	/	/	0	0	0	/	x	/	/	0	/	/	/	x	x	/	x	/	/	0	0	0	0	/	/	0
	HOMICIDE/ MANSLAUGHTER	/	/	/	/	x	0	0	0	/	/	0	0	0	/	x	/	/	0	0	/	/	x	x	/	x	/	/	0	0	0	0	/	/	0
AGAINST PERS. CARRIED PROP.	ROBBERY	x	x	/	/	x	/	0	0	/	/	/	/	0	/	x	/	/	0	/	/	/	x	x	/	x	x	/	0	0	0	0	/	/	/
	PURSE SNATCHING	/	/	0	/	/	0	0	0	0	/	/	0	0	/	x	/	/	0	/	/	0	x	x	/	/	/	0	0	0	0	0	/	/	/
	POCKET-PICKING	/	/	0	/	x	0	0	0	0	/	0	0	0	0	/	/	/	0	/	/	0	/	x	/	x	/	/	0	0	0	0	/	/	/
AGAINST STATION PROP.	STATION BURGLARY	/	x	0	0	x	/	0	0	0	/	0	0	x	/	x	/	/	x	/	x	/	x	x	/	x	/	0	0	0	0	0	/	/	/
	FARE EVASION	/	/	0	/	x	/	/	0	0	x	0	0	0	0	x	0	/	x	/	/	0	x	x	/	x	0	0	0	0	0	0	/	/	x
	VANDALISM	/	/	0	/	x	/	/	/	/	/	/	/	0	/	x	/	/	/	/	/	0	x	x	/	x	0	0	/	/	/	/	/	/	/
	PETTY THEFT	/	/	0	/	x	0	/	0	0	/	0	0	0	0	x	/	/	/	/	/	0	x	x	/	x	0	0	0	0	0	0	/	/	0
	TRESPASSING	/	0	0	/	x	0	0	0	0	/	0	0	0	0	/	x	0	/	x	/	/	0	x	x	/	x	0	0	/	0	0	0	/	/	0
	ARSON	/	/	0	0	x	/	0	0	0	/	0	0	0	0	x	/	/	x	/	/	0	x	x	/	x	0	0	0	0	0	0	/	/	0
	MISSILINGS	0	0	0	0	x	0	/	/	0	0	0	0	0	0	0	0	0	0	0	0	0	/	/	/	/	0	0	/	0	0	0	0	0	0
AGAINST PUBLIC	DRUG LAW VIOLATIONS	/	/	0	/	x	0	0	0	0	x	x	/	0	0	/	0	0	0	0	/	0	x	/	/	x	/	0	0	0	0	0	/	/	0
	SEX CRIMES	x	/	0	/	x	/	0	0	/	/	/	/	0	/	x	/	/	0	/	/	0	x	x	/	x	x	0	0	0	0	0	/	/	0
	DRUNKENESS	0	0	0	0	/	0	0	0	0	x	/	0	0	/	0	/	/	0	0	/	0	/	/	/	/	0	0	0	0	0	0	0	0	0
	DISORDERLY CONDUCT	/	/	0	/	/	/	0	0	/	/	0	0	0	/	x	/	/	0	/	x	0	/	/	/	x	0	0	0	0	0	0	0	0	/
	CONCEALED WEAPONS	0	0	0	0	/	0	0	0	0	x	0	0	0	0	0	0	0	0	0	0	0	x	/	/	/	/	0	0	0	0	0	0	0	0

Key: X = Effective / = Marginally Effective 0 = Ineffective
Source: Reference 30.

Table 22
GENERALIZED REVIEW OF COUNTERMEASURE ASSESSMENT TECHNIQUES

Countermeasure Assessment Techniques	Assessment Criteria					
	Data Requirements	Cost	Technical Expertise Required	Time Required	Statistical Reliability	Statistical Validity
Observation						
Behavioral	L	L	M	L	L-M	L-M
Environmental	L	L	M	L	L-M	L-M
Sample Surveys						
Security Perception	L-M	L-M-H	H	L-M	L-M-H	L-M-H
Victimization	L	M-H	M-H	M	M	M
Statistical Analysis						
Indices	M	L-M	M	L-M	M	M
Comparative Analysis	H	M	H	M-H	M-H	M-H
Relational Studies	H	M	H	M-H	M-H	M-H
Causal Analysis	H	H	H	H	H	H
Specialized Interviews						
Key Person	L	L-M	M	L-M	L-M	L-M
Critical Incident	L	L-M	M-H	L-M	L-M	L-M

Key: H = High M = Moderate L = Low

This generalized review highlights a basic trade-off which is encountered in most social science research contexts. The more useful and meaningful techniques, such as those involving a variety of statistical tools, are also those that are most demanding in cost, personnel, data, and time requirements. Many local governmental agencies lack adequate resources to employ such tools to their full capability. Where such resource constraints are a factor, less elegant and statistically sound techniques can still be applied to increase the information available for decision-making regarding choice among potential countermeasures.

The variety of lower cost countermeasure assessment techniques which are available, and which were reviewed in the previous chapter, is impressive. Where the basic-cost-versus-statistical acceptability trade-off must be resolved in favor of reduced costs, it is still possible to generate considerable information regarding the different available countermeasures. Many more site-specific details regarding the different assessment criteria listed in Table 22, as well as the more specific versions of each assessment technique which might be considered, are necessary to make these trade-offs. Table 22 is intended only as a first-cut guide in comparing, relatively, the different assessment techniques. Local detailing and site-specific interpretation of techniques is still essential.

Another approach for comparing the different assessment methods involves judgmental estimates of their applicability in analyzing the different countermeasure effectiveness criteria listed at the outset of this chapter. These effectiveness criteria apply to how well countermeasures themselves work: the extent to which they actually improve security, their acceptability to transit users, etc. Table 23 summarizes such a comparison of techniques.

This table indicates that the most pertinent application of *statistical analysis* is in documenting actual changes in transit security, but that statistical analyses could be applied to data collected via the other assessment techniques. Where budgetary limitations preclude extensive statistical analysis, the table also suggests that the other three categories of assessment technique also have fairly wide applicability. *Sample surveys* appear to have significant applicability in three areas (perceived security, transit user acceptability, transit personnel acceptability), while *specialized interview* techniques also appear applicable in these areas. *Observational* techniques appear to be generally less applicable than the others, although of significant value in assessing the adaptability/flexibility of different countermeasures.

Recommended Analysis Strategy

While Tables 22 and 23 offer only a coarse level of guidance in choosing among different countermeasure assessment techniques, the following approach or strategy in employing such techniques within a given locality considering AGT (and other capital-intensive transit) improvements is recommended:

1. *Begin with "Soft" Techniques.* Both observation and specialized interviews represent techniques which are relatively easy to employ, but which are also

Table 23
APPLICABILITY OF ASSESSMENT TECHNIQUES IN ESTIMATING COUNTERMEASURE EFFECTIVENESS

Techniques	Countermeasure Effectiveness Criteria						
	Improved Security		Adaptability/ Flexibility	Acceptability		Cost(1)	
	Actual	Perceived		Transit Users	Transit Personnel	Capital	Operating
Observation							
Behavioral	L	M	M	L	L-M	L	L
Environmental	L	L	H	L	L-M	L	L
Sample Surveys							
Security Perception	L	H	M	H	H		
Victimization	L	M	L-M	L	L-M		
Statistical Analysis(2)							
Indices	M						
Comparative Analysis	M						
Relational Studies	M						
Causal Analysis	H						
Specialized Interviews							
Key Person	L	M-H	M	M-H	L-M		
Critical Incident	L	M	L-M	L	L-M		

Key: H = High M = Moderate L = Low

(1) Cost estimation would generally be a separate part of the assessment process.

(2) Assumes use of secondary source or archival data; using data from sample surveys, statistical techniques could be applied against all effectiveness criteria.

''soft'' in the statistical rigor of their results. Nevertheless, such techniques can give a relatively quick feeling for the extent of both actual and perceived security risks on existing rail transit systems and in association with neighborhood residents located adjacent to existing transit systems. They can also be used to explore AGT security risk potentials, and countermeasure applicability.

2. *Employ Security Perception Surveys Wherever Possible.* The level of effort devoted to this type of survey can vary from a relatively low-budget ''panel of experts'' survey to a full-fledged sample survey of the patrons of an existing transit system. Such surveys, if well conducted, can offer considerable insight into the extent to which crime risks are perceived, and in what ways, within a specific locality. They can apply to both existing transit systems or proposed AGT systems.

3. *Evolve to ''Hard'' Techniques Gradually.* Hard or more rigorous techniques involving statistical analysis tools generally require a major commitment of time, staff, and budget. They also require considerable preparation, possibly including the collection of base line data for subsequent comparative purposes. Such techniques should be employed with caution, but, if budget is available, do offer the soundest methods for assessing countermeasures that either have been or could be implemented.

4. *Undertake Crime Prediction Efforts With Caution.* In association with other statistical analyses, it may also be desirable to undertake the sort of crime prediction efforts described earlier in Chapter 7. Such efforts also tend to be time and budget consuming, and often involve monumental data and statistical problems in sorting out the relative causes, both direct and indirect, of changes in criminal behavior. Under any rigorous attempt to employ the ''scientific method,'' however, crime prediction is a necessary first step in assessing the relative impact of different countermeasures.

5. *Adjust Budget and Staff Resources Accordingly.* Following this sequence of employing different assessment techniques, local agencies should allocate resources accordingly, also considering the time horizons available for analysis. Given the limited state-of-the-art of countermeasure assessment, there are real dangers of attempting to undertake "too much" analysis. Several of the less ambitious assessment techniques do offer a potential for generating considerable information, though much of it is perceptual and judgmental, on countermeasure effectiveness.

6. *Use Multiple Assessment Techniques Wherever Possible.* The ''triangulation'' principle frequently employed in the social sciences certainly has application in the context of this study. The general idea here is to employ two or more different assessment techniques in order to increase the amount of information available in choosing among different countermeasures. Using more than one technique implies, of course, that sufficient budget is available for more than one analysis effort. Probably some countermeasure can be assessed in more than one way, while the assessment of others can be undertaken only with considerable difficulty.

7. *Be Prepared to Revise Countermeasure Assessments,* as well as the techniques employed to derive them, as additional information is generated in other urban areas. The comparative ratings given in Tables 22 and 23 are clearly preliminary in nature and subject to revision as our experience with countermeasures and with the techniques for analyzing them grows. Just as these initial ratings are subject to further revision and clarification, the results of transit crime countermeasure assessments conducted in different urban areas are likely to evolve, as our technical understanding of the complex interactions involved is increased.

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Based upon demographic characteristics of American SMSAs and cities (with populations over 100,000), this research determines the direction and strength of linear relationships between robbery and aggravated assault crime rates and demographic variables. Although reducing the scale of analysis to a neighborhood level would encounter data constraints, this study identifies significant factors which should be considered in designing security measures for specific environments.

Broad and Columbia Subway Study Group, *Broad and Columbia Subway Development Study*. Philadelphia: Philadelphia City Planning Commission and the U.S. Department of Transportation, 1971.

A planning and design project undertaken by Temple University students and a group of planning consultants, the study initially assesses subway user and potential user needs based upon a consumer preference survey, a literature review, and an economic analysis of the area around the station.

Based upon these findings, design recommendations for the station, adjacent area, and the entire mass transit network are generated.

Budrick, Frank S., *The Crime-Correlated Area Model: An Application in Evaluating Intensive Police Patrol Activities*. Kingston, Rhode Island: University of Rhode Island, 1971.

A technical document which traces the development and evaluation of a crime-modeling technique, it employs a crime-correlated area model to determine the impact of intensive police patrol activities. This model is used both to compare actual vs. predicted crime in areas having increased patrols and to examine whether spatial or temporal displacement occurs. The model is used to evaluate a person-power experiment occurring over three one-month periods in Washington, D.C., in 1970. The study reveals that a significant increase in the visibility of police patrols led to an aggregate decline in criminal offenses. However, the magnitude of decline seems associated with the neighborhood environment. Few displacement effects were evident, but offenders did adapt to the changed environment over varying periods of time.

Chaiken, Jan M., "What's Known About Deterrent Effects of Police Activities," Rand Paper Series P-5735-1. New York: Rand Institute, 1977.

The effect of police activities on the incidence of crime is investigated through the use of cross-sectional studies (comparing the level of criminal justice sanctions such as arrests, convictions, etc., to the crime rates in various cities or states), longitudinal studies (showing a time series of crime incidence in certain jurisdictions where police deployment has changed), and response-time studies. A good overview of the impacts of police activities, the report basically supports the view that a substantial increase in police activity reduces crime for a period of time, but the duration and magnitude of the deterrence effects are essentially unknown.

Chaiken, Jan M.; Lawless, Michael W.; Stevenson, Keith A., *The Impact of Police Activity on Crime: Robberies on the New York City Subway System*. New York: Rand Institute, 1974.

The report analyzes the characteristics of subway robbery in order to determine an effective relationship between police deployment and crime rates in the New York subway system. One of the principal documents in transit crime literature, it focuses on police operations as a means of reducing crime (rather than other countermeasures) and discusses the "multiplier effect" and the "phantom effect" of crime and policing.

Corcoran, Denise and Heller, Nelson B., *Control of Regression Artifact Error in Evaluating the Effectiveness of Crime Reduction Programs*. St. Louis, Missouri: High Impact Evaluation Unit, Missouri Law Enforcement Assistance Council, 1974.

This study presents a method for estimating the magnitude of the statistical bias, called regression artifact, which favorably inflates program impacts in "before and after" comparison studies by overestimating "before" levels. This technique is applied to the results of the St. Louis High Impact Anti-Crime Program's Foot Patrol Project (implemented in 1972 in the highest-crime areas of the city) and reveals that the effectiveness of the program is probably overestimated by 27 percent.

Ferrari, N.D. and Trentacoste, M.F., "Personal Security on Public Transit." *Transportation Research Forum*, Vol. XV, No. 1, 1974.

A public attitude survey, this study was conducted in Chicago through the use of distributed and mailed questionnaires. The findings generally concur with the results of other public attitude studies, but an additional result reveals that the perception of safety changes during the year.

Frohman, Janet G., et al., "Crime Prevention Through Environmental Design," *Nation's Cities*., December, 1977.

The report describes NILECJ demo projects which test the concept of defensible space and other concepts which focus on crime prevention through environmental design. The focus is on physical, social, law enforcement, and management techniques designed to reduce crime and the fear of crime by reducing criminal opportunities and encouraging close cooperation between local agencies and residents.

Harris, Oscar, *A Methodology for Developing Security Design Criteria for Subways*. Pittsburgh, Pennsylvania: Carnegie-Mellon University, October, 1971.

Harris generates security design criteria for subway stations based upon the statistical correlation of three factors: (1) crime and harassment types, (2) physical characteristics of the neighborhood and station environment, and (3) nonphysical factors such as the characteristics of the victim, offender, police force, and public. It raises many points relevant to the incidence of crime and the proposed solutions.

Hawkins, Walter and Sussman, E. Donald, *Proceedings of Workshop on Methodology for Evaluating the Effectiveness of Transit Crime Reduction Measures in AGT Systems*. Cambridge, Massachusetts: U.S. Department of Transportation, July, 1977.

Drawing upon experiences from many transit systems, the workshop proceedings describe numerous countermeasures and also methodologies for evaluating the effectiveness of these techniques. The discussions focus on security measures appropriate for AGT systems.

Lindsey, Ralph M., "Security System for BART Subway, San Francisco, California," paper presented at U.S. Law Enforcement Assistance Administration Policy Development Seminar on Architecture, Design, and Criminal Justice, June, 1975.

This talk details the security problems experienced by the BART system and lends support to the concept that environmental design can reduce crime in the transit system and the need for large police deployments. In this system, parking lot thefts are the most severe crime problem.

Loss Prevention Diagnostics, Inc., *Three Solutions in Reduction of Criminal Opportunity in Mass Transportation.* West Caldwell, New Jersey, June, 1973.

The report develops three potential solutions for the reduction of crime and the improvement of real and perceived levels of protection. Solutions were determined based upon a process of collection, verification, evaluation, and interpretation of data related to the Chicago transit system. The solutions basically emphasized the remote monitoring of patrons, local monitoring of patrons, and train monitoring of patrons.

Metropolitan Washington Council of Governments, *Citizen Safety and Bus Transit: A Study of the Relationship Between Personal Safety and Bus Transit Usage in the Metropolitan Area.* Washington, D.C.: Urban Mass Transit Association, 1974.

A survey which investigates the role which personal safety considerations play in citizen use of bus transit, this report includes an analysis of transit crime reported by bus drivers, an investigation of actual incidences occurring at bus stop intersections, and a public attitude survey. Conducted in a manner similar to the Milwaukee study (see Sinha, Kumares C., "Personal Security in Buses ..."), this represents another of the six basic attitude surveys relating personal security and transit ridership. The report identifies the current methods of transit crime reporting, obstacles to accurate accounting and reporting, and prerequisites for maintaining public confidence.

Mitre Corporation, *A Review of Six Research Studies on the Relationship Between Police Patrol Activity and Crime*. Washington, D.C.: U.S. Department of Justice, LEAA, December, 1974.

The document presents an analytical and systematic review of seven research studies which deal with the impact of police patrols on crime. The contrast of study methodologies and results (i.e., indications of phantom effects, temporal displacement, etc.) could contribute to future efforts to measure the effectiveness of countermeasures.

Monte, Kay, *Crime in Mass Transportation Areas: An Overview*. Washington, D.C.: Department of Justice, LEAA, July, 1973.

As the title indicates, this is a cursory overview of transit crime--the major types of crime, the magnitude of different crimes in a number of transit systems, various crime countermeasures, and constraints which hinder accurate data compilation.

Schnell, John B.; Smith, Arthur J.; et al. (American Transit Association), *Vandalism and Passenger Security--A Study of Crime and Vandalism on Urban Mass Transit Systems in the United States and Canada*. Washington, D.C.: U.S. Department of Transportation, 1973.

A comprehensive study which analyzes the extent and seriousness of crime and vandalism on 37 U.S. and four Canadian mass transit systems. A range of countermeasures for dealing with these problems is examined and assessed, including:

1. Vandal-resistant materials.
2. Deterrence, protection, surveillance, and apprehension measures.
3. Community and educational programs.
4. Institutional cooperation.

Finally, the document reviews six studies of public attitudes/responses to transit crime.

Security of Patrons on Urban Public Transportation Systems, Report of the Workshop on Transit Security. Pittsburgh, Pennsylvania: Carnegie-Mellon University, 1975.

In a relatively concise document, this report provides a comprehensive exposure to transit crime and security research. It includes brief descriptions of the principal literature and summarizes characteristics possibly related to crime occurrence, probable crime sites, and possible security measures. In addition, it discusses transit crime in terms of actual and perceived risk relative to street crime and its effect on fashioning public attitudes toward transit systems. The little-researched areas of risk measurement and cost-benefit models for transit security improvement also are included. Finally, it discusses the potential applications of transit crime knowledge to AGT systems.

Sgarzi, Julie A., "Transportation Systems: Planning for Safety and Security," *Crime Prevention Review*, July, 1974, pp. 33-40.

This article describes the Southern California Association of Governments examination of security and public safety issues as they relate to the development of transportation plans for the Los Angeles region. By conducting a comprehensive overview of security and safety problems associated with other transit systems, they generated a manual of policing and design options that could be employed in their transportation planning efforts.

Shellow, Robert, et al., *Improvement of Mass Transit Security in Chicago*. Pittsburgh, Pennsylvania: The Transportation Research Institute and the Urban Systems Institute, Carnegie-Mellon University, June, 1973.

This document represents one of the most extensive investigations of crime and transit security that has been undertaken. It analyzes the nature of crime on the Chicago transit system, methodologies for comparing the magnitude of crime problems within a single system, countermeasures adapted to the crime characteristics, and public perceptions of security on the transit system.

Shellow, Robert, et al., "The Public's Perception of CTA Security," in *Improvement of Mass Transit Security in Chicago*. Pittsburgh, Pennsylvania: The Transportation Research Institute and The Urban Systems Institute, Carnegie-Mellon University, June, 1973.

This report details the results of an extensive public perception survey conducted in Chicago. Public attitudes toward the transit system are assessed in order to determine differences between the actual and perceived levels of crime, the effect of perceptions on ridership, and the differences between the perceptions of various socioeconomic groups. These findings provide the basis for countermeasure recommendations which are designed to impact most significantly upon public perceptions.

Shellow, Robert; Romualdi, James P.; Bartel, Eugene W., "Crime in Rapid Transit Systems: An Analysis and a Recommended Security and Surveillance System," *Crime and Vandalism in Public Transportation*. Washington, D.C.: Transportation Research Board, 1974.

Based upon a systematic analysis of transit crime patterns, ridership trends, a public perception survey, present security measures, and operating procedures on the Chicago transit system, this study attempts to identify the influence of crime on transit ridership and to develop measures for increasing patron and system security. This represents one of the basic attitude surveys referenced frequently in other documents and makes one of the initial efforts to calculate the risks associated with ridership. Furthermore, it describes the Teleview Alert System, a crime countermeasure which incorporates several surveillance and deterrence techniques.

Sidley, Norman A. and Shellow, Robert, *Automated Small Vehicle Fixed Guideway Systems Study Interim Report: Patron Security*. Minneapolis: Twin Cities Area Metropolitan Transit Commission, 1974.

Based upon summaries of Shellow's Chicago study (*Improvement of Mass Transit Security* ...) and the New York Rand study (*The Impact of Police Activity on Crime* ...), transit crime characteristics, risk features, crime sites, system features possibly related to crime occurrence, and countermeasures are identified. In light of these issues, personal security as it relates to alternative small-vehicle fixed-guideway transit systems (ranging in capacity from four to 30) is examined. This is the sole document which attempts to apply existing knowledge of rapid transit security to other technological forms.

Siegel, L.; Molof, M.; Moy, W., et al., *An Assessment of Crime and Policing Responses in Urban Mass Transit Systems*. McLean, Virginia: The MITRE Corporation, METREK Division, 1977.

An excellent state-of-the-art review of crime and policing responses in mass transit systems. It includes an analysis of: (1) the interactions among the transit environment, crime, and policing operations; (2) the effectiveness of various transit policing strategies and supportive anti-crime measures; and (3) new evaluative and experimental programs to improve policing effectiveness and to close gaps in our knowledge. Findings are based on an extensive literature survey, site visits, and interviews with transit police and security officials.

Sinha, Kumares C. and Roemer, Forrest P., "Personal Security in Buses and Its Effects on Ridership in Milwaukee," *Crime and Vandalism in Public Transportation*. Washington, D.C.: Transportation Research Board, 1974.

The Milwaukee attitude survey addresses the question of personal security on bus transit vehicles and its effect on transit ridership. A sample of bus riders and a group of randomly selected households along the chosen bus corridor were asked to complete questionnaires. The results indicate the relationship between perceptions of both crime and vandalism and attitudes toward bus ridership and the reality of transit crime. This represents one of the six basic attitude studies which have been conducted on this topic.

Southern California Association of Governments, *Transit Safety and Security: A Design Framework*. Los Angeles: Criminal Justice Planning Department, 1976.

The document identifies security and safety objectives for the operation of major transit systems and assesses crime patterns and safety problems for selected corridors in the Los Angeles region. It includes safety and security design criteria (i.e., illumination levels, landscaping, etc.) for a variety of transit facilities (i.e., park-and-ride facilities, subway stations).

Southern California Association of Governments, "Transit Security and Safety Study," Santa Monica, 1974.

This paper, prepared by the Criminal Justice/Transportation Technical Task Force, was generated in response to a contemplated Los Angeles transit system. It is a generalized discussion, based upon observations of other transit systems, of issues to be considered in the design and planning of a transit system.

Systems West, Inc., "Personal Security and PRT: Concepts and Methods for the Proposed Study to Estimate the Risk of Criminal Victimization to Potential Riders of a Given PRT Configuration," submitted to Denver Rapid Transit District, 1974.

The paper superficially describes concepts and analytical methods to be employed in developing a technique for calculating the risk of victimization for potential riders of PRT systems. It suggests that the exposure probabilities could be employed to project the effects of differing levels of victimization on PRT patronage. However, no attempt is made to test the hypothesis.

Tehan, Claire and Wachs, Martin, *Role of Psychological Needs in Mass Transit*. Washington, D.C.: U.S. Department of Transportation, 1972.

The article addresses the psychological considerations which should be incorporated into the planning and design of urban mass transportation systems. Recent psychological literature is reviewed in order to identify basic human needs which should be considered in efforts to improve the image and quality of transit systems. Conventional bus transit and two forms of personal rapid transit then are evaluated in light of these needs.

Thrasher, Edward J. and Schnell, John B., "Scope of Crime and Vandalism on Urban Transit Systems," *Crime and Vandalism in Public Transportation*. Washington, D.C.: Transportation Research Board, 1974.

The paper reports on an attempt to quantify the extent and seriousness of crime and vandalism on urban transit systems. Although many imprecisions in the recording of incidents and computing of vandalism costs impose limitations on the study, the authors believe the generation of a transit violent crime index, total crime index, and exposure index constitute a significant step toward measuring the incidence of transit crime in a manner which permits comparison to street crime.

Thrasher, Edward J. and Schnell, John B., "Studies of Public Attitudes Toward Transit Crime and Vandalism," *Crime and Vandalism in Public Transportation*. Washington, D.C.: Transportation Research Board, 1974.

This paper summarizes the findings of six public attitude studies conducted on the question of whether fear of transit crime influences use of the transit system. In general, it is found that the influence of transit crime varies with local conditions (i.e., the volume of crime, transportation alternatives, etc.) and that factors other than transit crime tend to be stronger influences on ridership decisions than crime and vandalism.

Thrasher, Edward J. and Schnell, John B., "Summary Report on Vandalism and Passenger Security in the Transit Industry," *Crime and Vandalism in Public Transportation*. Washington, D.C.: Transportation Research Board, 1974.

This report summarizes the major research study, *Vandalism and Passenger Security*, performed in 1973 under the auspices of the American Transit Association for the U.S. Department of Transportation. Whereas the objectives of the complete study were to appraise the national scope of transit crime and vandalism, to explore the means of controlling transit crime, and to generate recommendations, the summary focuses on a synopsis of currently employed countermeasures, their characteristics, and advantages/disadvantages.

Williams, Everard M., "Session on the Technological Breakthrough--Control of Mass Transit Vandalism and Other Crime," *International Conference on Urban Transportation*, Pittsburgh, Pennsylvania, 1971, pp. 92-102.

This paper basically outlines a systematic design for a study which would generate both a set of guidelines for the design and operation of transit systems intended to reduce vandalism and other crimes and a method for measuring the cost-benefit of crime, harassment, and vandalism. The report includes a review of the vandalism problem and a discussion of possible solutions.

APPENDIX—REPORT OF NEW TECHNOLOGY

The work performed under this contract was limited to a review of existing literature and analytic methods. No new technology was developed.

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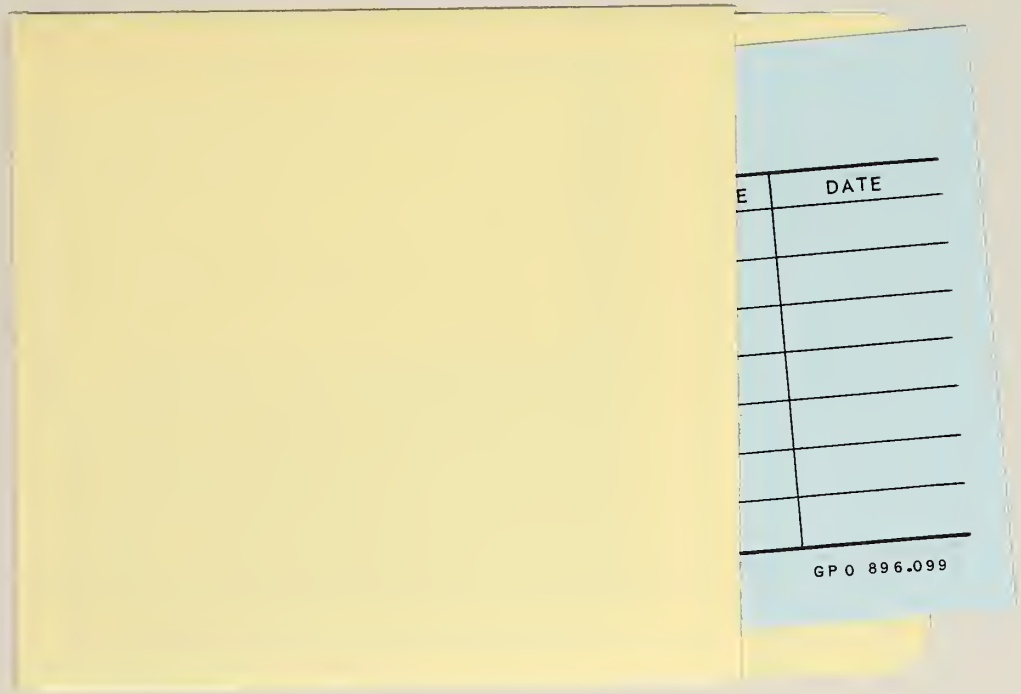
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